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M163

OCTOBER 4, 1956
EVERY OTHER THURSDAY

# MACHINE DESIGN

A PENTON PUBLICATION

621
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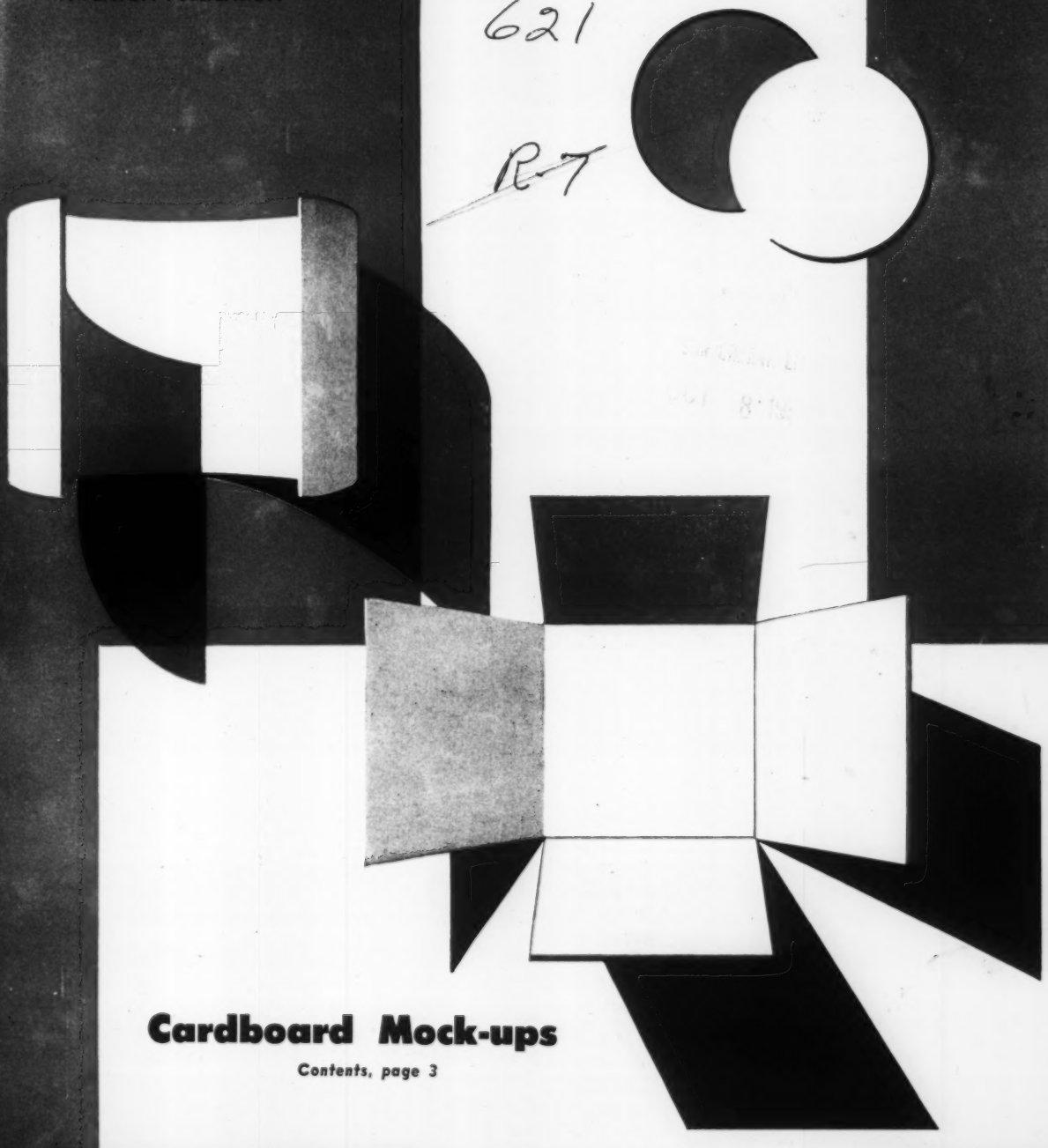

## Cardboard Mock-ups

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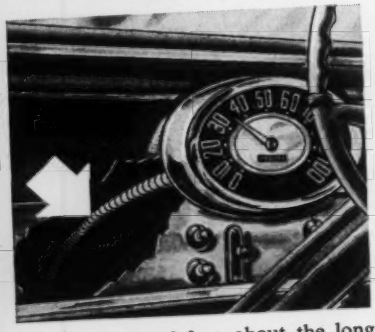
# FLEXIBLE SHAFT IDEAS for ENGINEERS

## 250,000 miles at 90 mph and still going strong



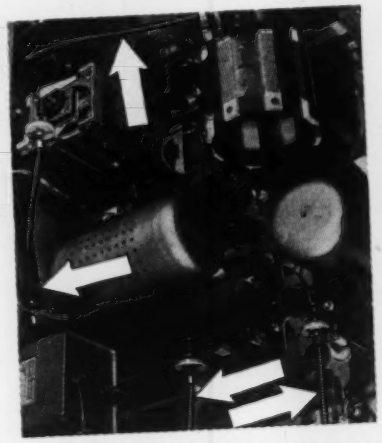
**To prove our claims** about the long life and dependability of S.S.White flexible shafts, we conducted accelerated life tests on a number of S.S.White speedometer shafts. After being run at 90 mph for 250,000 miles—the equivalent of being "driven" 10 times around the world—the shafts were still going strong.

### Here is information every designer should have

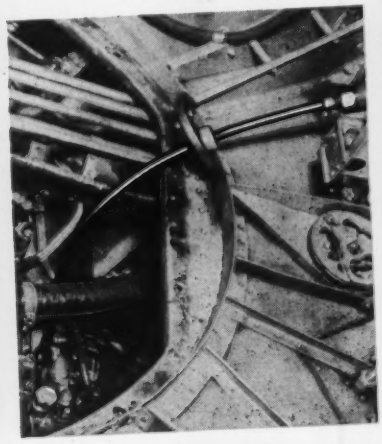
*Bulletin 5601 contains the latest information on flexible shafts. Included are full details on how to select and apply power drive flexible shafts as well as up-to-date tables showing flexible shaft sizes and characteristics.*

## For driving or controlling inaccessible parts flexible shafts do a better, more economical job

**Fewer design problems, better placement of elements, easier assembly are a few of the advantages**



In this electronic circuit, flexible shafts run between variable elements and control knobs give extra freedom in locating parts to best advantage.



A flexible shaft can be easily run around obstructions from one point to another as in this aircraft tach generator drive.

**The Ready Adaptability** of S.S.White flexible shafts in meeting varying design requirements makes them one of the most versatile elements available. And nowhere does this adaptability count for more than in providing an efficient, low-cost drive or control for parts that must be mounted in hard-to-get-at locations.

*For remote control applications, this means additional design freedom in mounting controls in more advantageous operating positions. It also means more efficient placement of controlled parts to satisfy space, operating and service requirements.*

As for transmitting power, using a flexible shaft to couple a driven part directly to its driving unit eliminates the need for additional parts such as universals, straight shafts and gearing. It provides a more efficient, quieter drive which needs no alignment and which can be installed faster, with fewer problems.

*S.S.White flexible shafts are made in a large selection of sizes and characteristics to enable you to meet a wide range of application requirements.*

Full engineering cooperation in selecting and applying flexible shafts to your products is always available.

F6-7

FIRST NAME IN FLEXIBLE SHAFTS

S.S.White

**S. S. WHITE INDUSTRIAL DIVISION, DEPT. 4, 10 EAST 40th ST., NEW YORK 16, N.Y.**

**Western Office: 1839 West Pico Blvd., Los Angeles 6, Calif.**

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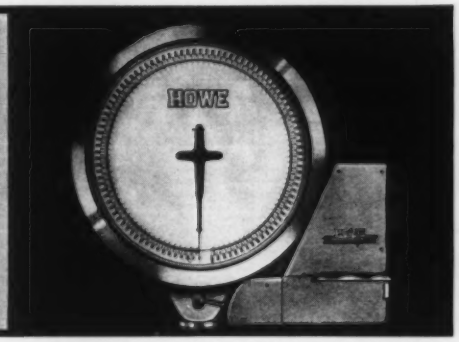
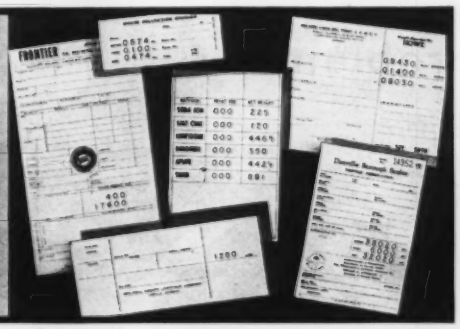
# Why Bodine motors were selected for Howe Scales

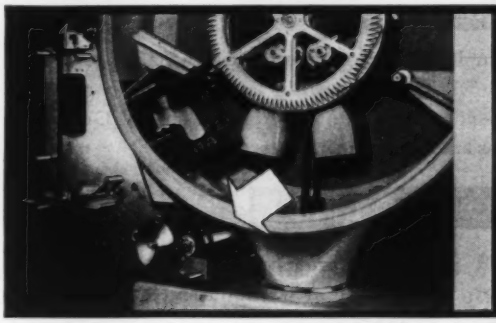



1 This is a two-in-one piece of equipment. It weighs a load and simultaneously records the weight.

2 A combination of a Howe Mechanoprint and a Tape Drive Dial, it's used for industrial applications such as weighing loaded trucks.



3 With the load in place, you press a bar, and the weight is automatically printed on a tape, ticket or form.



4 The printing mechanism of the Howe Mechanoprint is operated by this Bodine Type NSI-13, 1/40 fractional horsepower motor.

5 Manager of the Electrical Products Division of the Howe Scale Company is Mr. John S. Blackwell.

"The weight printing mechanisms of all Howe Mechanoprints are operated by Bodine Motors. We require a motor of highest quality and dependability, a motor able to withstand the abuse of frequent, intermittent service under all conditions. Bodine Motors have proved themselves to be entirely satisfactory in all respects. We are well pleased with their performance."

BODINE

BODINE

fractional horsepower

MOTORS

6 Mr. Blackwell answers the question, "Why Bodine Motors?" with some real good "reasons why"...see above.

7 Be sure your motor is as good as your product. Contact Bodine Electric Co., 2258 W. Ohio St., Chicago...or check your Sweet's file.

**BODINE MANUFACTURES FRACTIONAL HORSEPOWER ELECTRIC MOTORS FOR:**

adding machines
letter openers
sanders
vending machines
exhaust fans
duplicating machines
hand dryers
portable tools
sound recorders
air conditioners
check protectors
respirators
voltage regulators
x-ray timers
traffic signal timers
stirrers
calculating machines
envelope sealers
diesel governors

*. . . and for many other applications.*

*Ask for a sample copy of 'The Motorgram,' a bi-monthly publication discussing the application and design of fractional horsepower electric motors.*



Circle 504 on page 19

# C/R cooperative research

helps you solve sealing problems BETTER, FASTER

*These unequalled facilities are at your service*

## TESTING

Four complete C/R test laboratories are maintained solely to verify seal designs and materials with your specifications, with test runs in special C/R Machines and in customer units.

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THE PROFESSIONAL JOURNAL
FOR ENGINEERS AND DESIGNERS

# MACHINE DESIGN

October 4, 1956
Volume 28—No. 20

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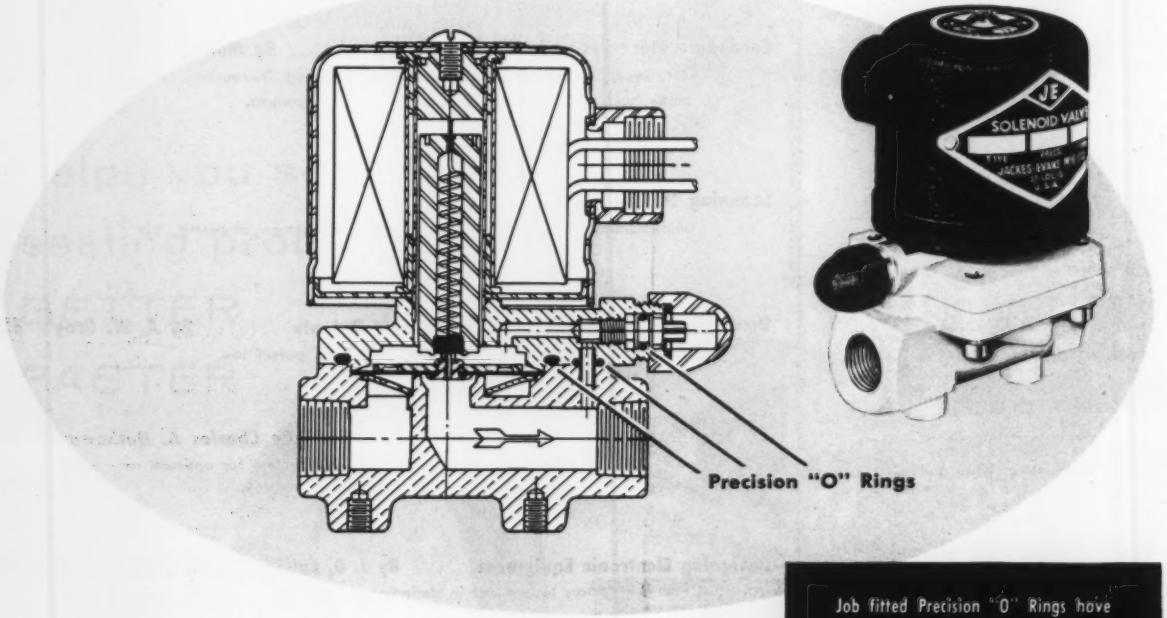
# SPECIAL PRECISION "O" RING meets low temperature flexibility requirements




*Resiliency maintained at 1 P.S.I.*

Job fitted Precision "O" Rings have solved hundreds of industrial, aircraft and automotive sealing problems.

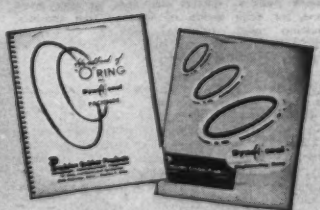
Precision "O" Ring compound 233-70 was developed especially for refrigerant service. It is used in the solenoid valves manufactured by Jackes-Evans Company of St. Louis, Mo. This compound assures the right chemical resistance and low temperature flexibility required for uninterrupted, maintenance free operation of refrigeration equipment using Freons.

Precision has developed thousands of special "O" ring compounds to provide the exact chemical and physical properties required for each specific job. Precision "O" Rings are quality controlled – compression molded – rigidly inspected – the finest made! They are made to all military and commercial specifications in hundreds of sizes.

What is your sealing problem? There is an expert – the Precision engineer – ready to help you in product design and "O" ring specifications. You can rely on him – and on Precision, the world's largest exclusive producer of "O" Rings. Put Precision in your plans!

Hot water circulation for heating in thousands of Levittown homes is controlled by Jackes-Evans Solenoid Valves—made extra dependable with Precision "O" Rings.

Write for your free copies of Precision catalogs on "O" Rings and Dyna-seals



**Precision Rubber Products Corporation** • "O" Ring and Dyna-seal Specialists

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**Canadian Plant at: Ste. Thérèse de Blainville, Québec**



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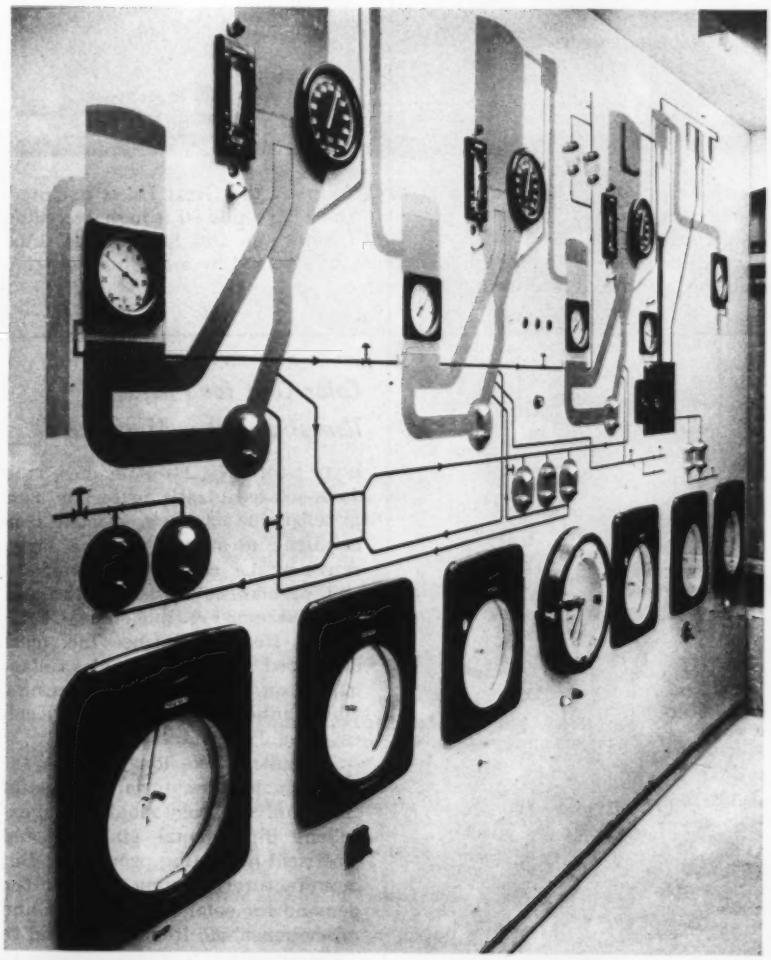
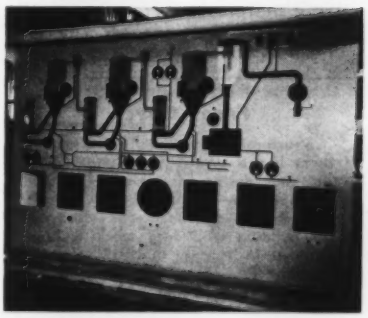
# Engineering News Roundup





COLORFUL CONTROL PANEL has been made by Littleford Bros. Inc. for Aluminum Co. of America and installed in the ALCOA Bauxite, Arkansas plant. The panel measures 99 x 144 in. and diagrams the operation of a salting-out evaporator. Equipment is represented graphically in suitable colors and instruments located in the panel diagram indicate events at stages in the flow process.

## *Broad Field Seen for Applied Solar Energy*

### Major Problems Are Food And Water Purification

SEATTLE, WASH.—A General Electric Co. engineer has said that the American home of the future might be heated, cooled and lighted by rooftop banks of solar batteries.

Norman F. Barnes of the G-E Laboratory in Schenectady pointed out that "with the limited fossil fuels—coal, oil and natural gas—and even the limited uranium fuels, man is turning to the sun, which, after all, is actually a prodigious nuclear reactor producing vast quantities of energy." Mr. Barnes' statements were made in an address at the recent Seattle Industrial Productivity Forum.

Mr. Barnes gave these examples of future developments involving the use of solar energy:

Extensive uses of radioactive isotopes for food sterilization and preservation, for minute measurements, for tracing oil flow or machine wear and for plant studies.

New methods for demineralizing salt water to meet a tremendous future demand for fresh water.

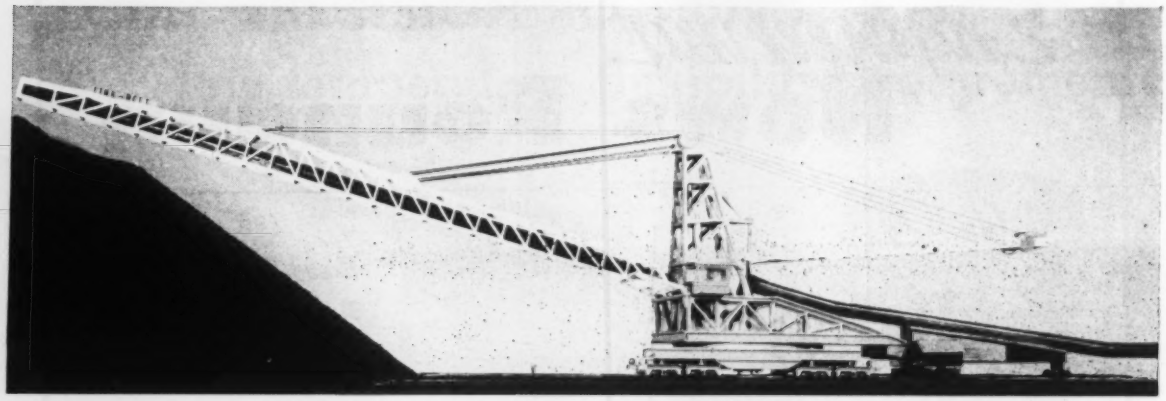
Man-made diamonds for industry, which uses approximately 11 million carats annually, or about two and one half tons worth nearly 35 million dollars.

The X-ray microscope, which can "see" inside materials.

Solar furnaces, Mr. Barnes said, could produce temperatures as high as 7000 F for metallurgical studies in the quest of unusual alloys.

A solar reflector 33 ft in diameter, he added, could be used as a steam generator to produce as much as 100 lb of steam per hour at 100 psi.

Housetop solar batteries might be flat-plate collectors consisting of one or more layers of glass



PELLET PILER, thought to be the world's largest traveling belt conveyor stacker, is being built for Erie Mining Co. by Link-Belt Co. This model illustrates relative size. At Hoyt Lakes, Minn., the stacker will be used to stockpile taconite pellets produced during winter months when navigation on the Great Lakes is closed. It will be capable of stacking a pile 90 ft high, weighing 4 million tons and covering an area 800 ft wide, 1300 ft long. The stacker will be fed by a trailing belt conveyor 1400 ft long.

placed over some good solar-energy absorbing materials.

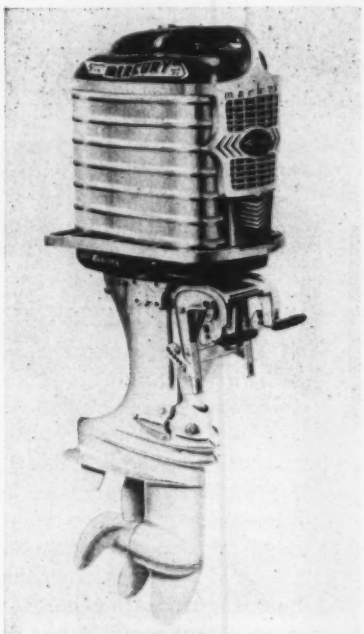
"Plants are able to carry out the process of photosynthesis—that of converting solar radiation into chemical energy," Barnes said. "While there is still much to be learned about such processes, there may be the future possibility of controlled growing of simple plant forms to convert the energy from the sun."

Barnes said one of the basic challenges confronting engineers today is to find an economically feasible method of converting sea water into fresh water to meet the nation's rapidly expanding demand.

Authorities have estimated that the nation's water consumption will double by 1975. The consumption today is estimated at more than 10,000 gallons per person annually.

---

**Two bachelor degrees in five years** is a scholastic objective becoming increasingly popular, reports Dr. Charles A. Seidle, director of admissions at Lehigh University. Number of freshmen starting the plan has increased from 5 in 1952 to 63 in 1956. Students graduate with one degree in arts and one in engineering. The plan provides broad background acknowledged desirable in many engineering careers.



MOST POWERFUL OUTBOARD is the claim of the Kiekhaefer Corp. for its new 60-hp Model 75. The new motor is 6-cylinder, in-line, 2-cycle, short-stroke design. Die-cast engine has 59.4 cu in. piston displacement. Standard electric starter is supplemented by a manual starter as a safety feature. A 12-v battery charged by an integral generator supplies current for lights, radio and other boat accessories. Throttle, neutral and direct reverse are obtained from single-lever remote control.

## Color Coat for Phenolics Useful on Other Materials

IRVINGTON, N. J.—Phenolics, the dark-colored plastic materials used in telephone handsets, electric iron handles and other appliance parts, can now be colored economically and permanently without the use of primers or multiple coats. Chemists at Rexton Finishes Inc. have developed an industrial finish, based on Bakelite epoxy resins, which adheres firmly to the glossiest phenolic surfaces.

Phenolics have long been a favorite molding material because of their low cost, easy moldability, excellent dimensional stability and electrical insulating properties. But manufacturers, trying to meet the demand for color in appliances and other household items, have had to consider more expensive thermosetting materials because most pigmented finishes chip off the phe-

### Front Cover

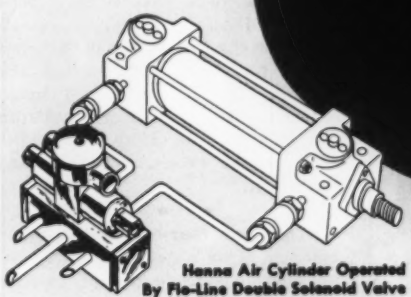
**Structurally, cardboard may not seem like a particularly useful material. But design-wise, cardboard can be important—particularly when made into models and mock-ups. Methods for building cardboard mock-ups are outlined in Morton Matthew's article on Page 76, which provides the keynote theme for George Farnsworth's front cover.**

THEY'RE

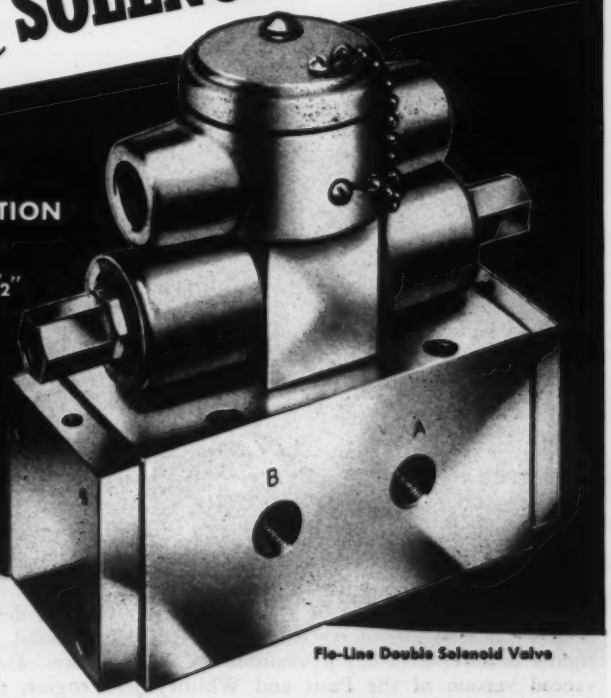
# NEW!

# HANNA *Flo-Line* SOLENOID VALVES

4-WAY VALVES
FOR AIR OPERATION
UP TO 150 PSI
SIZES: ¼", ⅜", ½"



Hanna Air Cylinder Operated By Flo-Line Double Solenoid Valve With Flo-Set Speed Control Valves




Flo-Line Double Solenoid Valve

Hanna has designed and built new and unusual features in their Flo-Line Solenoid Valves . . . features that result in economy, more versatile operation and safety. Here are some of them:

- **Bubble Tight Spool** positively sealed by "O" rings.
- **Dust-Tight, Splash-Proof Design** to seal out dirt and moisture, and assure trouble free performance.
- **Few Moving Parts** for longer valve life.
- **Full Pipe Capacity** for all internal passages.
- **Wide Range of Temperatures and Pressures** —40° F. to 125° F.; 20 to 150 psi air. Options permit air pressure to 250 psi and even vacuum!
- **Enclosed Solenoid Coils** for safe operation.
- **AC or DC Service,** coils are available for most voltages and frequencies.
- **Meets JIC Recommendations** in all respects when ordered with optional manual over-ride.
- **Side or Manifold Porting** for easy installation and convenient piping.
- **Choice of Spools** permits selection of a standard valve for most applications.
- **Manual Over-ride,** an optional feature, allows equipment to be tested before final electrical installations are made and provides a means of operating the valve in case of electrical failure.
- **Junction Box** for ease in making electrical connections.
- **Modern Clean Cut Appearance**

You'll surely want the complete details given in the new Hanna Flo-Line Catalog No. 261. See your classified telephone directory or Thomas' Register for the name of your nearest Hanna Representative—or write us direct.

## Hanna Engineering Works

**HYDRAULIC AND PNEUMATIC EQUIPMENT • CYLINDERS AND VALVES**

**1751 N. Elston Ave., Chicago 22, Illinois**

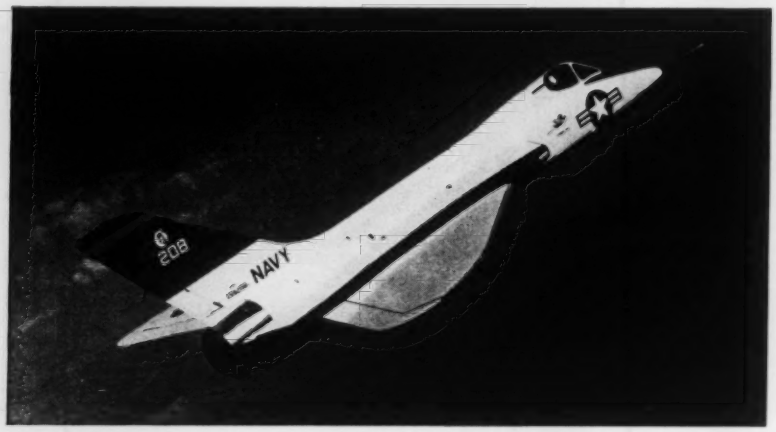


Circle 507 on page 19

nolics even with a prime coat. With the development of the new finish, color is available in a single coat.

Epoxy resins used in the new enamel are well known for their adhesive properties. While the new finish was developed especially for use on phenolics, it works equally well on steel, tin, brass, copper, aluminum, zinc, glass, wood, and many plastics. Two steel bars coated with the new enamel can be banged together until the metal dents without chipping the coating.

The new enamel will cure by air drying, force drying or baking. Air-dry pieces can be handled in about two hours.




SKYLANCER, developed by Douglas Aircraft Co. and designated X-F5D, is shown here in one of the first photos officially released. The new Navy fighter is faster than any jets now in squadron service. Powered by an advanced version of the Pratt and Whitney J-57 engine, the carrier-based Skylancer is designed for all-weather, high-altitude performance.

## American Homes May Hold Cure for Engineer Shortage

HARTFORD, CONN.—More emphasis must be placed upon the sciences throughout the American educational system if we are to maintain our standard of living and meet the threat of rapidly advancing Russian technology. This was the theme of a recent talk by S. E. Skinner, vice president of General Motors in charge of the Accessory Group. Mr. Skinner indicated that the encouragement to study sciences must originate in the American home.

Our population increase alone represents a challenge to education that must be met if we are to continue a growing economy, he said. Our role of leadership in the free world is still another challenge. "It it hardly necessary to point out that while might never makes right, strength is a necessary attribute of leadership in today's world climate.

"Right now the United States needs more engineers and scientists, and this need will increase rather than diminish in the years to come," Mr. Skinner said. "The time lag between fundamental discovery and its development into things useful for our daily living has been shrinking."

Where does the United States stand with respect to trained manpower? "The picture is not a pleasant one to contemplate. It has been estimated that we need a yearly influx of 45,000 to 50,000 engineers and scientists. Currently our schools are graduating half as many. In the Soviet Union, more than that number go from the technical schools into state employment each year."

So far we have the edge on Russia in total numbers of scientific and technical personnel, Mr. Skinner said, but it has been estimated that in less than five years the Soviets will overtake us.

# Topics

**Accuracy of one part in 10 million** is possible with a new type of interferometer developed by a Northwestern University physicist. The instrument can be used to measure such objects as filaments or to study optical corrosion.

• • •

Television viewers who have a yen but not enough dollars for color sets may be cheered by news of a possible subsititute. British researchers are working on a broadcasting method that produces an illusion of color on the screens of black-and-white sets.

• • •

**Plastic dike covers** have been proposed as a waterproof substitute for the woven willow branches used for five centuries by the Dutch. The lamination of nylon mesh between layers of vinyl film would cover the width of the dike to prevent erosion of the sand below it.

• • •

**Three or four-color memory** is possessed by a newly patented information storage unit. The system uses photographic film on which colored marks have specific meaning. Recording and reading off are accomplished through an arrangement of filters, lights and mirrors.

• • •

**Making steel without a blast furnace** is the subject of current experiments in England. The new Cyclosteel process blows fine droplets of liquid iron ore through a gaseous mixture of powdered coal and oxygen. The result is a crude form of steel.

• • •

**Seven diesel-electric paddle tugs** have been ordered by the British Admiralty. Paddle-driven tugs have proved to be the most suitable for moving aircraft carriers and other large warships in the confined waters of dockyard basins.

• • •

Longest nonstop helicopter flight of 1199.07 miles was made recently by two Army aviators in a Vertol H-21C. The previous distance record was 778.3 miles.

• • •

**Boon to broom wielders** in Los Angeles is the city's adoption of motor scooters for street sweepers. These workers now ride scooters equipped with shovels, brooms and trash containers.

# Unitool*... *a fast, easy, low-cost way* to produce prototype bevel gears!

Now you can produce small quantities of spiral bevel, Zerol® bevel and hypoid gears with a comparatively small capital outlay and without specially trained personnel.

You can reduce the time and expense it takes to change your angular drive from a drawing board idea to a working model, too, because the Unitool Method produces good quality gears directly from the initial calculations.

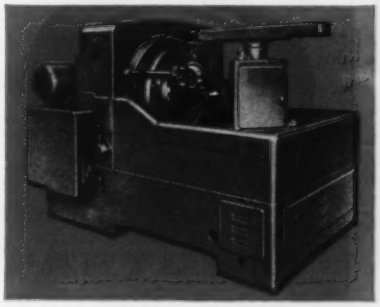
The Unitool Method is based on a fundamentally different theoretical approach to bevel gear generation. Only six different cutters are required to cut gears up to 14" pitch diameter—spiral bevel and Zerol bevel pairs of any ratio; hypoid pairs 3:1 ratio and higher. Because these cutters have a wide overlap in range, cutter diameter is not critical.

Calculations are short enough and easy enough for you to do in your own plant. Correct tooth thickness and position of contact are easily determined without requiring special operator training.

The Unitool Method is designed especially for the Gleason No. 106 and No. 116 Hypoid Generators which feature increased universal cutter tilt.

*Trademark

We will be glad to send further information on the Unitool Method and the two Gleason Generators best suited for it at your request.



*The Gleason No. 106 Hypoid Generator is a high-speed machine for spiral bevel, Zerol bevel and hypoid gears up to 8½" pitch diameter. Its larger counterpart, the No. 116 Hypoid Generator, handles the same type gears up to 18" pitch diameter.*

**GLEASON WORKS**

*Builders of bevel gear machinery for over 90 years*

1000 UNIVERSITY AVE., ROCHESTER 3, N. Y.

Circle 508 on page 19

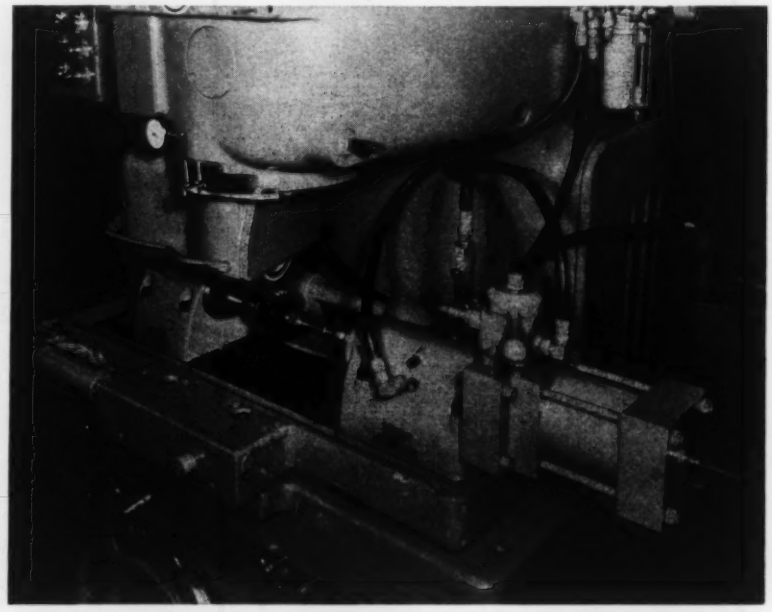
The proportion of our students in high school who study physics, algebra, geometry and chemistry has dropped alarmingly since 1900, he said, while in Russia all secondary students take these subjects and those who show promise are pushed along.

## New Process Hones Teeth To Make Gears Run Quietly

DETROIT, MICH.—A new process that applies honing principles to the finishing of hardened gear teeth to improve sound characteristics has been developed by National Broach & Machine Co. The new process removes nicks and burrs; corrects small heat-treatment errors in spacing, profile lead or eccentricity; and improves surface finish. Gear honing is claimed adaptable to both high and low volume production.

The honing process is designed to remove metal up to 0.002-in. over pins. Since the action tends to generate an accurate tooth form, small corrections are made in tooth form and lead which improve the sound characteristics of a hardened gear.

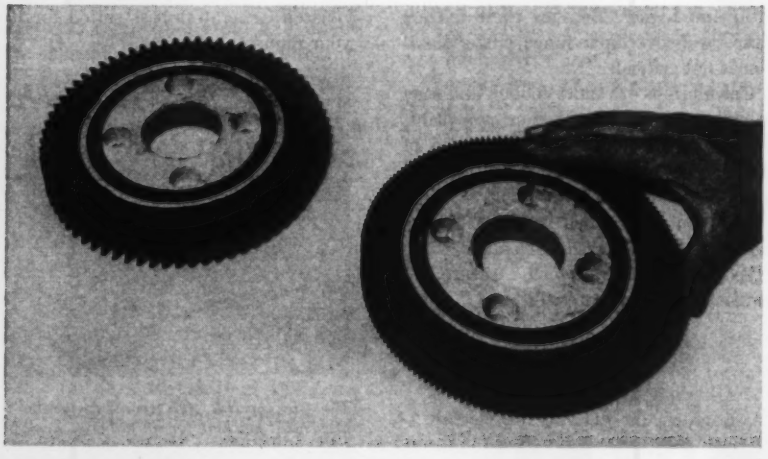
Small pinions are rotated at speeds up to 3000 rpm for the honing process. Larger gears are honed at speeds corresponding to about 800 surface fpm.



Gear honing machine adaptable to manual, semi-automatic or fully-automatic loading. Work table is tilted by air cylinder, manually controlled, for loading and unloading.

The process is performed on either of two machines that use a new gear tooth honing tool. This tool is essentially an abrasive-impregnated helical gear that is run in mesh with a hardened work gear at high speed. The hardened gear is driven by the honing tool and traversed back and forth across the tool in a path parallel to its axis. The work gear is run in both directions during the process.

Of the two machines currently available for gear honing, one is equipped with an automatic work loader and optional brake loading. The other machine is used when more tooth correction is desired and is adaptable to manual, semi-automatic and automatic loading arrangements.



Abrasive-impregnated gear honing tools have the form of finished gears. The amount of helix angle on the teeth depends on the helix angle of the work gear and the amount of crossed-axes angular setting.

## TV Gives Close Look At Operating Gas Turbines

DEARBORN, MICH. — Closed-circuit TV is permitting observations, never before possible, of the performance of engine components at the Pilot Gas Turbine Laboratory of the Ford Motor Co. Manufacturer of the TV equipment is the Dage Television Div. of Thompson Products Inc.

The system has been used in a variety of applications which required observation of the performance of engine components located in hazardous areas. Particular phenomena observed include flame patterns in combustion chambers, the operation of critical engine linkages, and the characteristics of engine lubrication.

FACTS about NEW DEPARTURE BALL BEARINGS

## aircraft turbine bearings...

# DESIGNED for HIGH SPEEDS, LOADS and TEMPERATURES

New Departure split inner ring bearing mounting for jet engine main shaft

Today's leading production jet engines turn on New Departure split inner ring bearings . . . an out-ahead development of New Departure's continuing Aircraft Research Program.

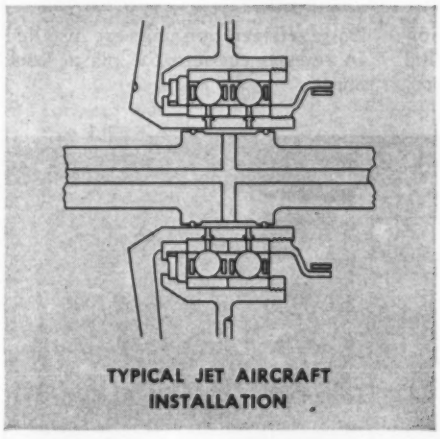
These turbine bearings handle heavy thrust loads from either direction and major radial loads with unexcelled dependability. Two-piece inner ring construction facilitates cleaning, inspection and assembly. It also permits use of the maximum number of balls of largest possible diameter with high thrust shoulders and one-piece separator construction.

While these bearings meet today's demand, tomorrow's needs command the facilities of the New Departure Aircraft Research Program. Already bearing development looks ahead to operational speeds in the order of 100,000 rpm and temperatures close to 1000° F. Write for New Departure's Aircraft Turbine Ball Bearing Folder TB-56. New Departure, Division of General Motors, Bristol, Connecticut.

### MEDIUM and LARGE TURBINE BEARINGS

| Basic Bearing No. | NOMINAL DIMENSIONS | | |
|---|---|---|---|
| | Bore | O.D. | Width |
| LL34 | 6.6929 | 9.0551 | 1.102 |
| LL36 | 7.0866 | 10.2362 | 1.614* |
| LL44 | 8.6614 | 12.5984 | 1.929* |
| L22 | 4.3307 | 7.0866 | 1.280* |
| L24 | 4.7244 | 7.4803 | 1.280* |
| L26 | 5.1181 | 7.8740 | 1.280* |
| L28 | 5.5118 | 8.6614 | 1.574* |
| L30 | 5.9055 | 8.5060 | 1.235* |
| L32 | 6.2992 | 9.4488 | 1.338 |
| L34 | 6.6929 | 10.6299 | 1.815* |
| 207 | 1.3780 | 2.8346 | .669 |
| 209 | 1.7717 | 3.3465 | .938* |
| 212 | 2.3622 | 4.3307 | .866 |
| 213 | 2.5591 | 4.7244 | .905 |
| 214 | 2.7559 | 5.1181 | 1.023 |
| 215 | 2.9528 | 5.1181 | 1.181* |
| 216 | 3.1496 | 5.5118 | 1.023 |
| 219 | 3.7402 | 6.6929 | 1.259 |
| 220 | 3.9353 | 7.0886 | 1.385* |
| 222 | 4.3307 | 7.8740 | 1.771* |
| 224 | 4.7244 | 8.4646 | 1.850* |
| 228 | 5.5118 | 9.4488 | 2.007* |
| 232 | 6.2992 | 10.1992 | 1.660 |
| 307 | 1.3780 | 3.1496 | .826 |
| 315 | 2.9528 | 6.2992 | 1.456 |

*Puller groove, inner ring or both rings



TYPICAL JET AIRCRAFT INSTALLATION

SEE "WIDE WIDE WORLD" SUNDAYS—NBC-TV

NEW DEPARTURE BALL BEARINGS

GM GENERAL MOTORS

NOTHING ROLLS LIKE A BALL

**BALL BEARINGS MAKE GOOD PRODUCTS BETTER**



Circle 509 on page 19

## Folded Plastic Sandwich Forms Refrigerator Walls

### Versatile Process Permits Varied Sizes, Shapes, Styles

COLUMBUS, O.—A new refrigerator, made of light-weight plastic and metals that can be cut to any size or shape, has been announced by Westinghouse. Use of the new materials and manufacturing process permit a variety of refrigerators to match any styling scheme.

Built-in versions, using all-plastic bodies with steel doors, are already on test in homes. Additional pilot production of similar models is under way.

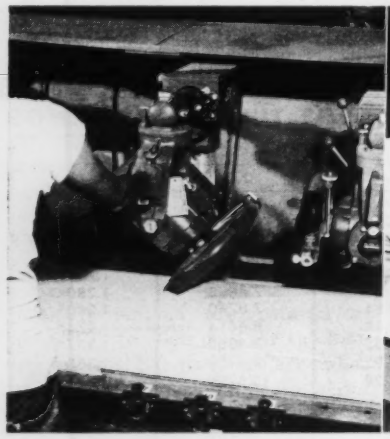
Two experimental models each have 13 cu ft capacity and are intended for built-in use. Both also have steel doors but weigh 150 lb less than conventional steel models of the same capacity.

Basis of the new technique is a one-piece, laminated three-layer sandwich. The exterior and interior layers can be almost any light-weight metal or plastic. The sandwich filler is 2½ in. of polystyrene foam insulation. Refrigerators made with it cost about the same as conventional models. The new refrigerator has relatively no tooling cost. Its basic panels can be cut to any size and shape with an electric saw.

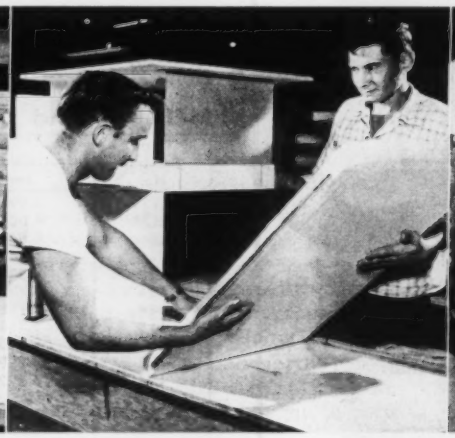
The cabinet of the new refrigerator is formed from a single flat sheet of the sandwich material. Corners are mitred out and the cabinet folded together like a carton with the corners bonded and sealed by a plastic resin which is cured electronically.

Because of the structural advantage inherent when walls are bonded to a core, it is expected that ultimately refrigerator walls made with this material can be thinner than in the models announced.

Using the new technique, a complete new model, exclusive of steel or chrome trim, can be developed and put into production in less than two weeks, according to Westinghouse. This, it is said, is the first major step toward achieving "dynamic obsolescence" in the refrigerator field.

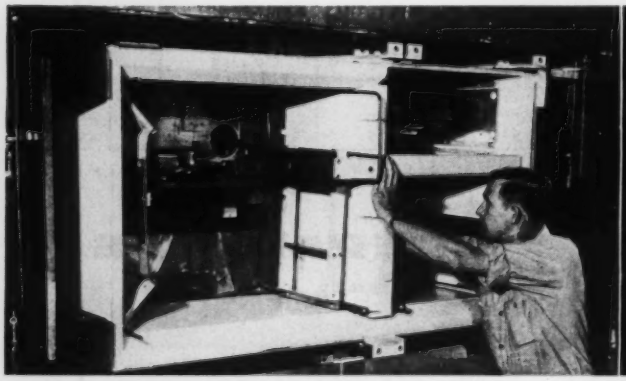


In an early operation, V-joints are cut from the plastic to enable the formation of cabinet corners.

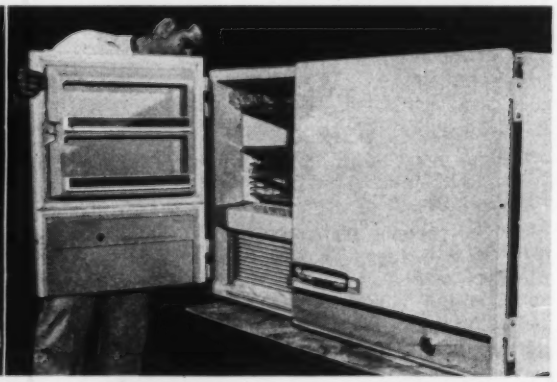


The cabinet is formed by folding the trimmed sandwich material, like a carton, around interior partitions.

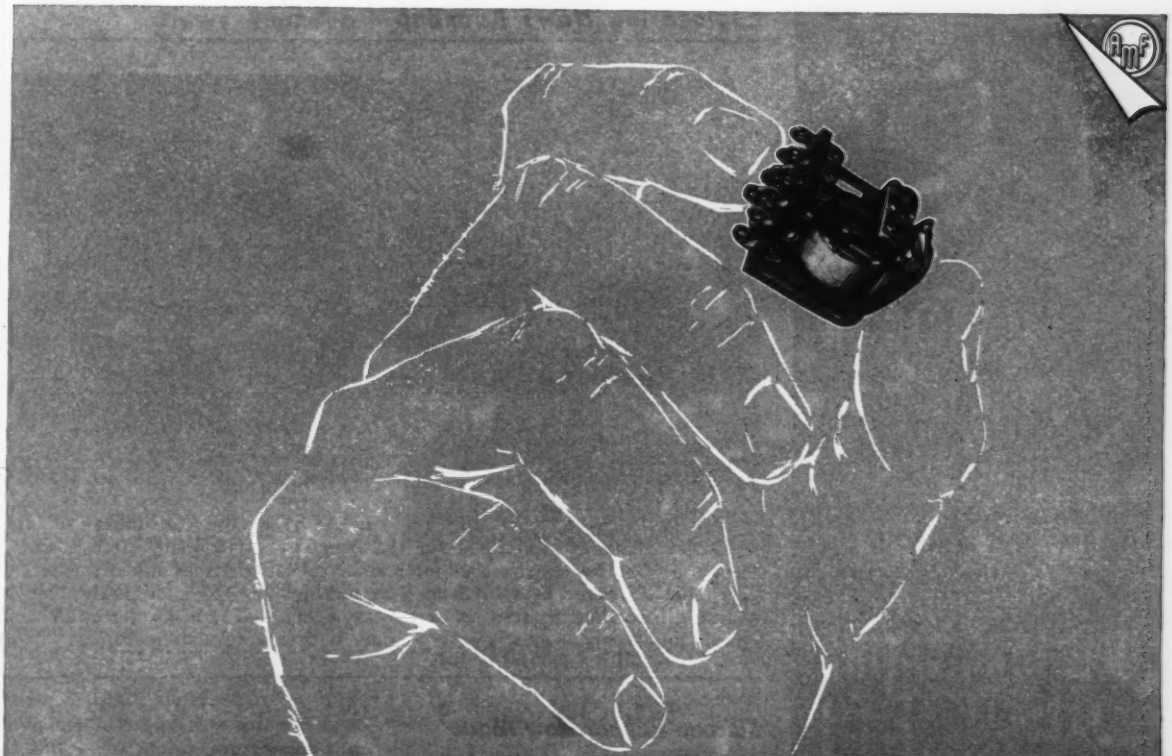
Basic refrigeration units are installed in recesses cut into the plastic back sheet.



The basic cabinet, assembled, is placed in a positioning jig where epoxy resin seals are set by welding.



Final assembly is completed as the doors are hung. These are steel; will be plastic in later models.



# NEW! SUB-MINIATURE 3-POLE P & B RELAY FOR MULTIPLE SWITCHING

**KM SERIES**
**ENGINEERING DATA**

**CONTACTS:**
Max. 3PDT. 3/32" Dia. Silver
2 amps, 115V 60 cy. resistive

**VOLTAGE RANGE:**
Up to 48V DC nominal

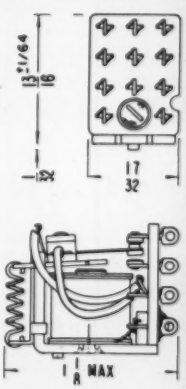
**COIL RESISTANCE:**
Up to 6700 ohms

**COIL POWER REQUIREMENT:**
1 watt

**TEMPERATURE RANGE:**
−45° C to + 55° C

**PULL-IN:**
75% of nominal voltage

**TERMINALS:**
Solder lugs




This new P&B KM series was engineered to meet the pressing demand for miniaturization and multiplicity of action within a single relay. Application possibilities cover a wide field of diverse products, such as:

SMALL BUSINESS MACHINES
ALARM SYSTEMS — INTERCOM SYSTEMS
AUTOMATIC TOYS — REMOTE CONTROLS

Here is only one of the great family of P&B relays . . . one of more than 20,000 design variations. Custom modification of relays, too, is a P&B specialty. Thus you have one dependable source for ALL your relay needs!

KM RELAY ABOVE SHOWN ACTUAL SIZE

**P&B STANDARD RELAYS ARE AVAILABLE AT MORE THAN 500 DISTRIBUTORS IN ALL PRINCIPAL CITIES**

Potter & Brumfield inc.
PRINCETON, INDIANA
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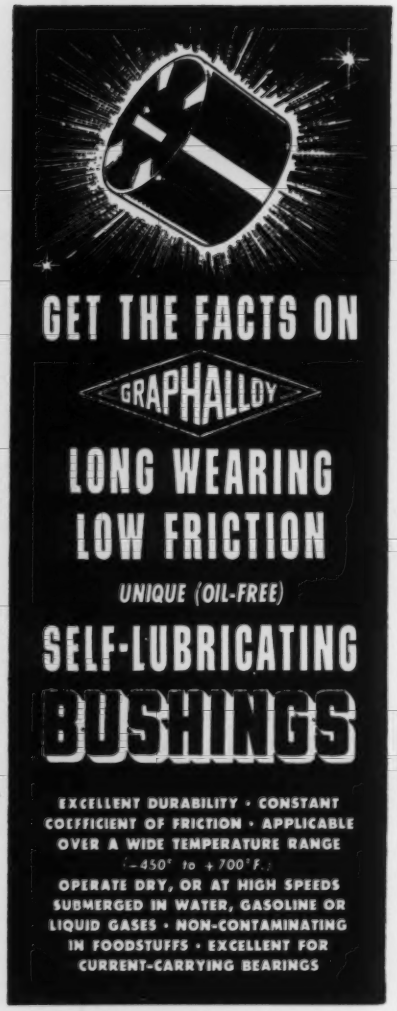
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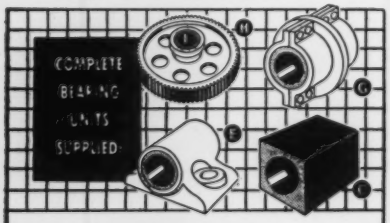
LONG WEARING
LOW FRICTION
UNIQUE (OIL-FREE)
SELF-LUBRICATING
BUSHINGS
EXCELLENT DURABILITY • CONSTANT COEFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE (−450° to +700°F.)
OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR LIQUID GASES • NON-CONTAMINATING IN FOODSTUFFS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

GRAPHALLOY is widely used for self-lubricating piston rings, seal rings, thrust and friction washers, pump vanes.




BRUSHES • CONTACTS

GRAPHALLOY has high-performance electrical properties: *low electrical noise, low and constant contact drop, high current density, minimum wear!*

Brush Holders and Assemblies, Coin Silver Slip Rings and Assemblies available.

*USE OUR 40 YEARS OF DESIGN EXPERIENCE!*

GRAPHITE METALLIZING CORPORATION

1048 Nepperhan Ave. • YONKERS, NEW YORK

☐ Please send data on Graphalloy Oil-Free BUSHINGS.
☐ Send data on BRUSHES and CONTACTS.

NAME & TITLE
COMPANY
STREET
CITY ZONE STATE

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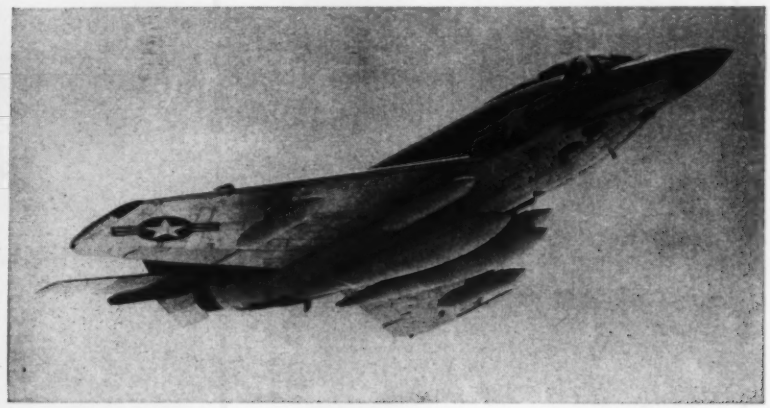


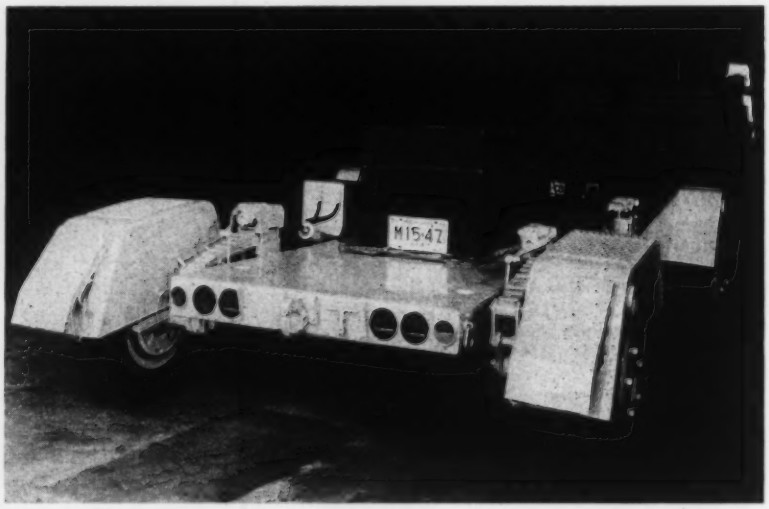
FAST DELIVERY OF LETHAL LOADS is the capability of the F3H-2N "Demon," developed for the Navy by McDonnell Aircraft Corp. Here the "Demon" carries four interceptor rocket packages and two external fuel tanks. Powered by an Allison J-71 turbojet, the "Demon" is the Navy's fastest all-weather fighter. It serves as a missile-bearing interceptor and atomic bomb carrier and is now on duty with operational squadrons.

## Silicone Rubber Now Made With Foam Structure

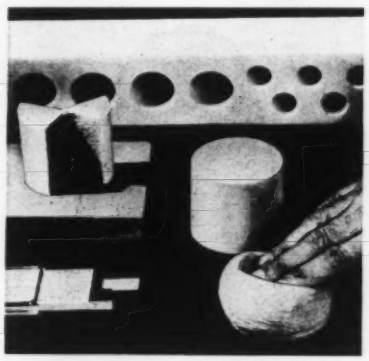
NEW HAVEN, CONN.—A new material, silicone rubber with foam structure, has been developed by The Connecticut Hard Rubber Co.

Called Cohrfoam, the new silicone foam rubber is light in weight and remains soft and resilient over a temperature range of −100 to 480 F. It recovers shape instantly after being compressed for long periods at elevated temperatures.

The new rubber can be molded into complex shapes and has found applications as airframe seals. Where exceptional abrasion resist-




COMBINATION TRACTOR-SLED is this new cargo trailer recently developed by American Motors Corp. for Army Ordnance and the Air Force. The lightweight vehicle is designed to be transported by air. A hydraulic mechanism retracts the wheels to convert the trailer to a sled and to save space in air transport. Trailer shown has 4000-lb capacity—one of six planned with capacities from 500 to 10,000 lb.



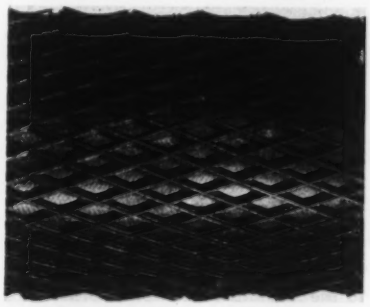
ance is required, Cohrfoam can be covered with Dacron fabric or Teflon film.

Physical data include:

Compression-deflection: 0.75 to 1.25 psi; 25 per cent compression, 1 in. thickness.

Compression set: 14 per cent (300 F, 22 hrs. 50 per cent compression, 1 in. thickness)

Thermal conductivity: 0.33 to 0.45 BTU/hr/sq/ft/in./deg. F.



A GOOD GRIP on all types of packages is provided by the design of the new Goodyear Wedge-Grip conveyor belt cover. Criss-crossing ribs in the belt are step-shaped so that as the belt wears down, a new rib is presented for use.

## Low-Cost Motor Runs on Air Film

VERMILION, O.—A low-cost electric motor which, it is claimed, will never require bearings or lubrication has been unveiled at Air-Guide Engineering Laboratories.

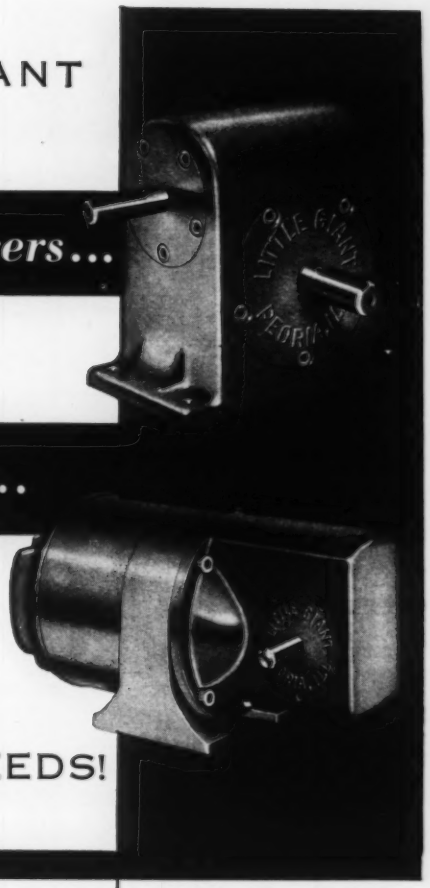
The rotating assembly of the motor is supported within the stator on a film of fluid which may be a

(*Continued on Page 22*)

LITTLE GIANT

*Speed Reducers...*

*Gearmotors...*



DESIGNED FOR YOUR SPECIFIC NEEDS!

You furnish the specifications—Little Giant engineers will custom-design power transmission equipment to match the application.

Basic components are work-proven standard parts for reduced costs, while housings, mountings, shaft positions and other features are engineered for your specific needs.

There's no cost, no obligation, for this personalized design service. Just submit details of your needs, we will do the rest.

**CHECK THESE LITTLE GIANT FEATURES**

- Worm integral with input shaft. Worm thread and all diameters hardened and ground from alloy steel.
- Bearings and shafts designed for high overhung loads.
- High efficiencies through use of ground alloy worm and 3½% nickel bronze gear.
- Clean, compact design.
- Speed Reducer ratios: 5-4/5:1 to 100:1 within a 1½" to 2⅝" center range.
- Gearmotors ratings: 1/50 to 1 H.P.

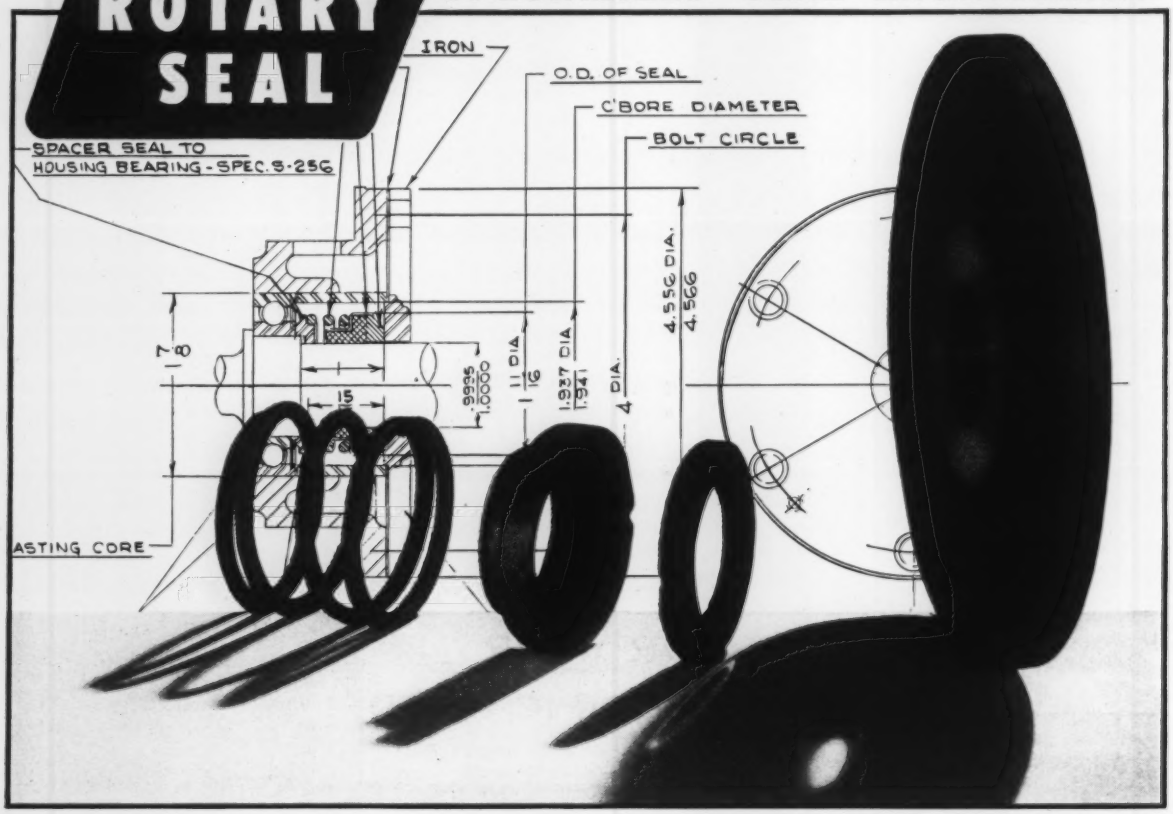
LITTLE GIANT
PRODUCTS, INC.
1530-50 NORTH ADAMS ST.
PEORIA 3, ILLINOIS

*Manufacturers of quality products since 1918*

Circle 512 on page 19

# ROTARY SEAL

## SPECIALIZED SEAL ENGINEERING




## is developing new ways to assure top performance in AUTOMOBILE AIR CONDITIONING COMPRESSORS

Automobile air conditioning, a recent innovation, poses difficult new problems for the compressor maker. The Seal shown represents many months of designing effort, guided by years and years of specialized experience, to produce a Seal that's *right in every detail* — to assure steady unit performance uninterrupted by sealing difficulties.

This Seal, which has been developed for a leading manufacturer of compressors, well exemplifies the skill and patience of ROTARY SEAL engineering. That's our business — solving hard Shaft Sealing problems where production quantities of Seals are involved, by applying the basic ROTARY SEAL principles which opened the way to successful mechanical Shaft Sealing when this company introduced them years ago.

Major assignments for important Seal developments are keeping us mighty busy at present; but if special difficulties are besetting *your* development programs, and production quantities of Seals are involved, we'll be glad to help if we can.

THE ROTARY SEAL Division of MUSKEGON PISTON RING CO.
mechanical seals for rotating shafts

*Shaft-Sealing with Certainty*

2022 NORTH LARRABEE STREET
CHICAGO 14, ILLINOIS, U. S. A.



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**EDITORIAL CLIPSHEETS**—So you won't have to "clip" this issue, we'll be glad to send a personal copy of any article as long as the supply lasts. Just fill in the page number and title of article in the place provided on the Yellow Card.

## Index to New Parts & Helpful Literature

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**MACHINE DESIGN**
**OCT. 4, 1956**

Circle item number for information on products advertised or described or copies of literature.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 401 | 426 | 451 | 476 | 501 | 526 | 551 | 576 | 601 | 626 | 651 | 676 | 701 | 726 | 751 |
| 402 | 427 | 452 | 477 | 502 | 527 | 552 | 577 | 602 | 627 | 652 | 677 | 702 | 727 | 752 |
| 403 | 428 | 453 | 478 | 503 | 528 | 553 | 578 | 603 | 628 | 653 | 678 | 703 | 728 | 753 |
| 404 | 429 | 454 | 479 | 504 | 529 | 554 | 579 | 604 | 629 | 654 | 679 | 704 | 729 | 754 |
| 405 | 430 | 455 | 480 | 505 | 530 | 555 | 580 | 605 | 630 | 655 | 680 | 705 | 730 | 755 |
| 406 | 431 | 456 | 481 | 506 | 531 | 556 | 581 | 606 | 631 | 656 | 681 | 706 | 731 | 756 |
| 407 | 432 | 457 | 482 | 507 | 532 | 557 | 582 | 607 | 632 | 657 | 682 | 707 | 732 | 757 |
| 408 | 433 | 458 | 483 | 508 | 533 | 558 | 583 | 608 | 633 | 658 | 683 | 708 | 733 | 758 |
| 409 | 434 | 459 | 484 | 509 | 534 | 559 | 584 | 609 | 634 | 659 | 684 | 709 | 734 | 759 |
| 410 | 435 | 460 | 485 | 510 | 535 | 560 | 585 | 610 | 635 | 660 | 685 | 710 | 735 | 760 |
| 411 | 436 | 461 | 486 | 511 | 536 | 561 | 586 | 611 | 636 | 661 | 686 | 711 | 736 | 761 |
| 412 | 437 | 462 | 487 | 512 | 537 | 562 | 587 | 612 | 637 | 662 | 687 | 712 | 737 | 762 |
| 413 | 438 | 463 | 488 | 513 | 538 | 563 | 588 | 613 | 638 | 663 | 688 | 713 | 738 | 763 |
| 414 | 439 | 464 | 489 | 514 | 539 | 564 | 589 | 614 | 639 | 664 | 689 | 714 | 739 | 764 |
| 415 | 440 | 465 | 490 | 515 | 540 | 565 | 590 | 615 | 640 | 665 | 690 | 715 | 740 | 765 |
| 416 | 441 | 466 | 491 | 516 | 541 | 566 | 591 | 616 | 641 | 666 | 691 | 716 | 741 | 766 |
| 417 | 442 | 467 | 492 | 517 | 542 | 567 | 592 | 617 | 642 | 667 | 692 | 717 | 742 | 767 |
| 418 | 443 | 468 | 493 | 518 | 543 | 568 | 593 | 618 | 643 | 668 | 693 | 718 | 743 | 768 |
| 419 | 444 | 469 | 494 | 519 | 544 | 569 | 594 | 619 | 644 | 669 | 694 | 719 | 744 | 769 |
| 420 | 445 | 470 | 495 | 520 | 545 | 570 | 595 | 620 | 645 | 670 | 695 | 720 | 745 | 770 |
| 421 | 446 | 471 | 496 | 521 | 546 | 571 | 596 | 621 | 646 | 671 | 696 | 721 | 746 | 771 |
| 422 | 447 | 472 | 497 | 522 | 547 | 572 | 597 | 622 | 647 | 672 | 697 | 722 | 747 | 772 |
| 423 | 448 | 473 | 498 | 523 | 548 | 573 | 598 | 623 | 648 | 673 | 698 | 723 | 748 | 773 |
| 424 | 449 | 474 | 499 | 524 | 549 | 574 | 599 | 624 | 649 | 674 | 699 | 724 | 749 | 774 |
| 425 | 450 | 475 | 500 | 525 | 550 | 575 | 600 | 625 | 650 | 675 | 700 | 725 | 750 | 775 |

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**OCT. 4, 1956**

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| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 401 | 426 | 451 | 476 | 501 | 526 | 551 | 576 | 601 | 626 | 651 | 676 | 701 | 726 | 751 |
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| 415 | 440 | 465 | 490 | 515 | 540 | 565 | 590 | 615 | 640 | 665 | 690 | 715 | 740 | 765 |
| 416 | 441 | 466 | 491 | 516 | 541 | 566 | 591 | 616 | 641 | 666 | 691 | 716 | 741 | 766 |
| 417 | 442 | 467 | 492 | 517 | 542 | 567 | 592 | 617 | 642 | 667 | 692 | 717 | 742 | 767 |
| 418 | 443 | 468 | 493 | 518 | 543 | 568 | 593 | 618 | 643 | 668 | 693 | 718 | 743 | 768 |
| 419 | 444 | 469 | 494 | 519 | 544 | 569 | 594 | 619 | 644 | 669 | 694 | 719 | 744 | 769 |
| 420 | 445 | 470 | 495 | 520 | 545 | 570 | 595 | 620 | 645 | 670 | 695 | 720 | 745 | 770 |
| 421 | 446 | 471 | 496 | 521 | 546 | 571 | 596 | 621 | 646 | 671 | 696 | 721 | 746 | 771 |
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**BUSINESS REPLY CARD**
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**Penton Building**
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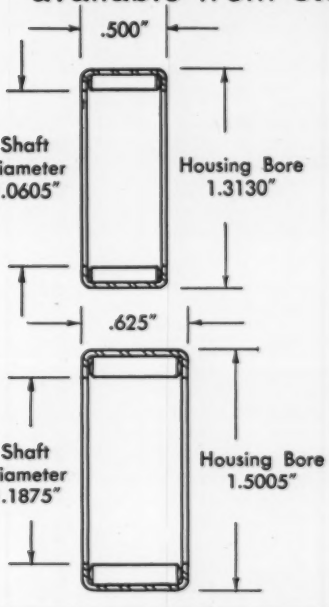
# NEW KAYDON THIN-SHELL NEEDLE BEARINGS

Illustration is 2-times actual size of needle bearing

Two standard sizes available from stock




## You get these Kaydon design advantages:

1. **Greater effective length needle rollers for MORE CAPACITY (41% on ½" width)... LONGER LIFE (2.8 times as much on ½" width)**
2. **Simplified construction that SAVES you money**
3. **Pre-packed lubrication that SAVES assembly time**

HERE it is! Kaydon's new thin-shell needle bearing. A bearing that gives you more of everything — more capacity... more economy... *plus longer life* than any other comparable bearing, because of greater effective length of spherical end rollers.

This new bearing is ready for you right now from stock in two standard sizes (illustrated). Other sizes will be available later.

For complete specifications, ask for Data Sheet No. K562—write, call or wire Kaydon of Muskegon.

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

*All types of ball and roller bearings — 4" inside diameter to 124" outside diameter... Taper Roller • Roller Thrust • Roller Radial • Bi-Angular Roller • Spherical Roller • Needle Roller • Ball Radial • Ball Thrust Bearings*



Circle 514 on page 19

**NEW . . . NEW!**

# Gear-Grip

## Flexible Coupling

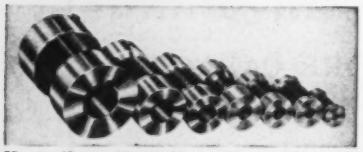
**The most revolutionary design advancement for integral H.P. in a century!**

**Positive power transmission of rated load. Gear teeth on end casting match special rubber tube section.**

- **Load ranges—2½ H.P. to 25 H.P.**
- **Shaft sizes—¾" to 1⅞".**
- **Specified lengths to design requirements.**
- **Prevents end thrust.**
- **"By Eye" shaft alignment.**
- **No lubrication required.**
- **Shaft Safety features.**

## Dyna-Line . . .

**The finest flexible coupling in single unit construction—specifically designed for fractional H.P.**



5R 4R 3R 2R 1R 0R 00R

- **True Flexibility and Torsional Resilience for quiet, load-plus power transmission without extreme deflection or twist.**
- **Lengths varied to design specifications in each series.**
- **Load ranges—1/15 to 1½ H.P.**
- **Shaft sizes — 3/16" to ¾".**
- **Lowest O.D. for highest torque capacity.**

**Write for Catalogs and Technical Bulletins.**

**Guardian PRODUCTS CORP.**
COUPLING DIVISION

DEPT. M-106, 1215 E. SECOND ST.
MICHIGAN CITY, INDIANA

*Circle 515 on page 19*

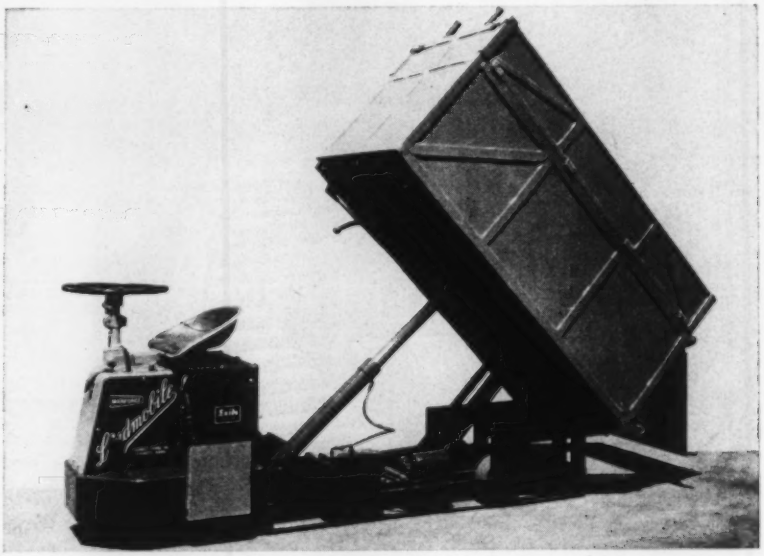

## Engineering News Roundup

(*Continued from Page* 15)

gas or liquid. The load-supporting film of fluid acts in the gap region.

Thousands of hours of running time have been accumulated on motors which "float" in room air. A fractional horsepower motor has been operated successfully in room air while the full rated power was absorbed by a belt driving a fan.

In applications characterized by high radial loads or shock loads, the air or liquid is fed into the air gap region under pressure — the motors still requiring no end-bell housings.



IN-PLANT DUMP TRUCK, designed by Loadmobile for Market Forge Co. permits trash collection operations by a single unit and a maximum of three operators. Dump body has a capacity of 2½ cu yd; measures 6¾ ft long, 3 ft wide. Hinged sides make greater loads possible. Body is tilted hydraulically to 45 degrees. Speed is 4 mph and rated load 1000 lb.

# Meetings

AND EXPOSITIONS

**Oct. 18-19—**

**National Conference on Industrial Hydraulics.** Twelfth Annual Meeting to be held at the Sherman Hotel, Chicago, sponsored by Illinois Institute of Technology. Further information can be obtained from Joseph J. Kowal, Conference Secretary, Armour Research Foundation of Illinois Institute of Technology, 10 W. 35th St., Chicago 16, Ill.

**Oct. 22-24—**

**Purdue University.** First conference on Manufacturing Automation cosponsored by *Automation* Magazine. Additional information may be obtained from Editor, *Automation,* Penton Building, Cleveland 13, Ohio.

**Oct. 24-25—**

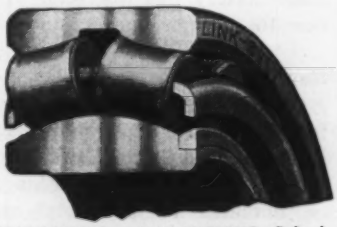
**American Society of Mechanical Engineers.** ASME - AIME Joint Fuels Conference to be held at Sheraton Park Hotel, Washington, D. C. Further information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

**Oct. 25-26—**

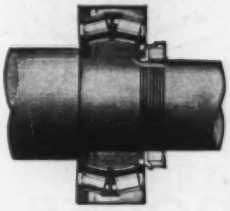
**Society for Advancement of Management.** Annual Fall Conference to be held at Hotel Statler, New York. Additional information is available from society headquarters, 74 Fifth Ave., New York 11, N. Y.

## MORE FACTS on why more and more leading manufacturers choose Link-Belt bearings

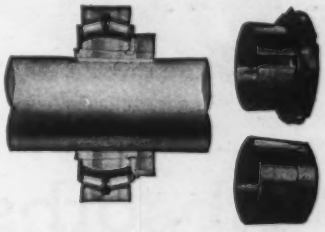
**ALLIS-CHALMERS MOTOR GRADER** capitalizes on the ability of Link-Belt self-aligning roller bearings to handle high shock loads.



**FREE-ROLLING — SELF-ALIGNING.** Spherical inner ring is free to align in any direction. Load is distributed over entire roller assuring full load capacity. Destructive edge loading cannot occur.



**DIRECT SHAFT MOUNTING** with bearing being pressed or shrunk on the shaft. Especially desirable to achieve maximum economy on production applications.



**ADAPTER MOUNTING** permits use of commercial shafting without machining. Easy installation and removal of adapter-type bearings are provided by the tapered sleeve, locknut and lockwasher.

### Builders of industry's heaviest equipment

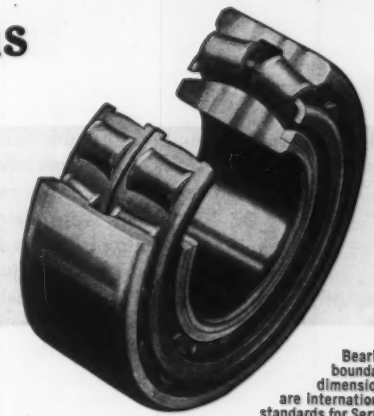
# choose this self-aligning roller bearing for toughest applications

You're in company with blue-chip machinery makers when you specify high-capacity Link-Belt self-aligning roller bearings. Wherever tough-duty equipment calls for self-contained, pre-adjusted bearings and simple mounting, you'll find them on the job . . . handling heavy radial and thrust shock loads.

These self-aligning roller bearings have internationally standardized boundary dimensions and are available everywhere. Link-Belt also makes industry's most complete line of ball and roller bearing blocks. This includes pillow blocks plus flange, flange cartridge, cartridge, take-up and hanger blocks. Ask any one of the 40 Link-Belt offices for data Book 2550.

**LINK-BELT**

**Ball and Roller Bearings** 13,903-A



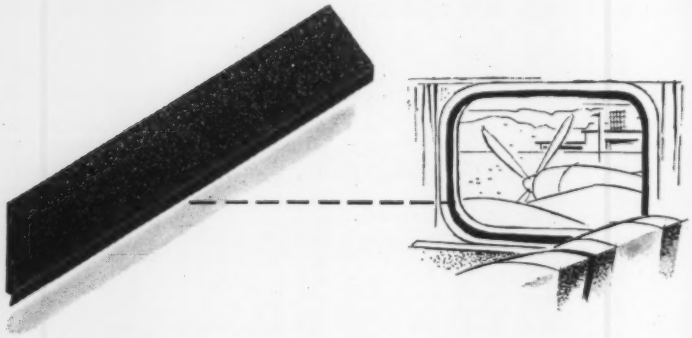
Bearing boundary dimensions are International standards for Series 22200 and 22300—22500-A and 22600-A.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

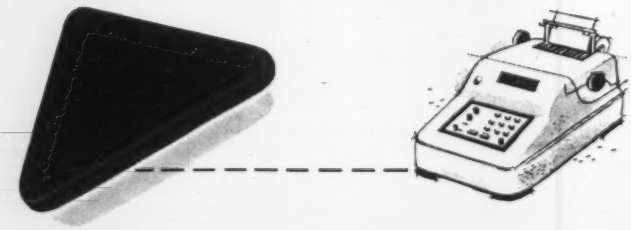


Circle 516 on page 19

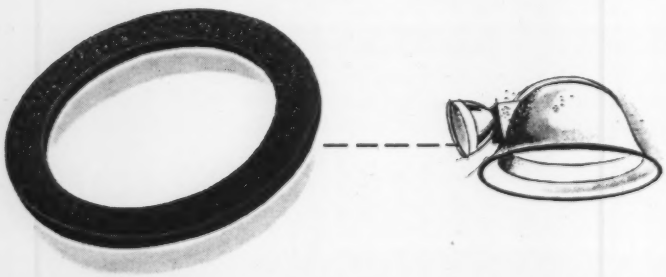
# Insulates



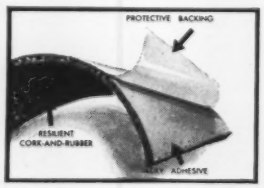
# Skid-proofs



# Absorbs shocks



**Armstrong DK-153** is a resilient cork-and-sponged-rubber composition with a pressure-sensitive adhesive backing. DK-153 is used today in many different ways in hundreds of industrial products . . . it serves as an insulating strip in aircraft windows, skid-proofs office accounting machines, cushions shock and prevents damage in mine safety equipment. You can get DK-153 in rolls, strips, sheets or die-cut shapes, in thicknesses from 1/32 to 3/16 inch. In any form DK-153 is easy to apply: just peel off its protective covering and press material into place. (DK-153 is also available without adhesive backing.) For samples, write to Armstrong Cork Company, 7310 Dean St., Lancaster, Penna.




**Armstrong DK-153**

*. . . used wherever performance counts*

Circle 517 on page 19


## News Roundup

**Oct. 30-Nov. 1—**

**National Fluid Power Association.** Fall Meeting to be held at the Hotel Cleveland, Cleveland. Further information can be obtained from association headquarters, 1618 Orrington Ave., Evanston, Ill.

**Oct. 31-Nov. 2—**

**Gray Iron Founders Society Inc.** Annual Meeting to be held at The Homestead, Hot Springs, Va. Additional information is available from society headquarters, 930 National City — E. Sixth Bldg., Cleveland 14, O.

**Oct. 31-Nov. 2—**

**Society for Experimental Stress Analysis.** Annual Meeting and Exhibit to be held at the Deshler-Hilton Hotel, Columbus, O. Further information can be obtained from society headquarters, P. O. Box 168, Cambridge 39, Mass.

**Nov. 1-2—**

**Society of Automotive Engineers Inc.** National Diesel Engine Meeting to be held at the Drake Hotel, Chicago. Further information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

**Nov. 2-3—**

**Sixth Annual Tool Engineering Conference** to be held at Illinois Institute of Technology, Chicago. Conference is sponsored by IIT, Northwestern and Illinois universities and the Illinois chapters of the American Society of Tool Engineers. Further information can be obtained from Prof. Samuel E. Rusinoff, Mechanical Engineering Dept., Illinois Institute of Technology, Technology Center, Chicago 16, Ill.

**Nov. 7-9—**

**Steel Founders' Society of America.** Technical and Operating Conference to be held at the Carter Hotel, Cleveland. Additional information can be obtained from society headquarters, 606 Terminal Tower, Cleveland 13, O.

**Nov. 8-9—**

**Society of Automotive Engineers**

Inc. National Fuels and Lubricants Meeting to be held at the Mayo Hotel, Tulsa, Okla. More information can be obtained from society headquarters, 29 W. 39th St., New York 18, N. Y.

**Nov. 12-16—**

**National Electrical Manufacturers Association.** Annual Meeting to be held at the Traymore Hotel, Atlantic City, N. J. Further information is available from association headquarters, 155 E. 44th St., New York 17, N. Y.

**Nov. 13-15—**

**Investment Casting Institute.** Fourth Annual Meeting to be held at the Sheraton Cadillac Hotel, Detroit. In addition, a Vacuum Metals Symposium will be held Friday, November 16. Further information can be obtained from ICI headquarters, 27 E. Monroe, Chicago 3, Ill.

**Nov. 14-17—**

**Society of Naval Architects and Marine Engineers.** Sixty-fourth Annual Meeting to be held at the Waldorf-Astoria Hotel, New York. Further information can be obtained from society headquarters, 74 Trinity Place, New York 6, N. Y.

**Nov. 25-30—**

**American Society of Mechanical Engineers.** Annual Meeting to be held at Hotel Statler, New York. Further information is available from society headquarters, 29 W. 39th St., New York 18, N. Y.

**Nov. 25-30—**

**22nd National Exposition of Power and Mechanical Engineering** to be held at the Coliseum, New York, under the auspices of the American Society of Mechanical Engineers. Additional information can be obtained from exposition headquarters, 480 Lexington Ave., New York 17, N. Y.

**Nov. 26-30—**

**Third International Automation Exposition** to be held in the Trade Show Bldg., New York. Further information can be obtained from Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.


AN IMPORTANT
NEW CATALOG
FOR YOUR
FILES!

WINSMITH, Inc., 16 Elton Street
Springville, (Erie County), N. Y.

Gentlemen: Please send me a copy of Catalog 155 on the new Series "C" Speed Reducers.

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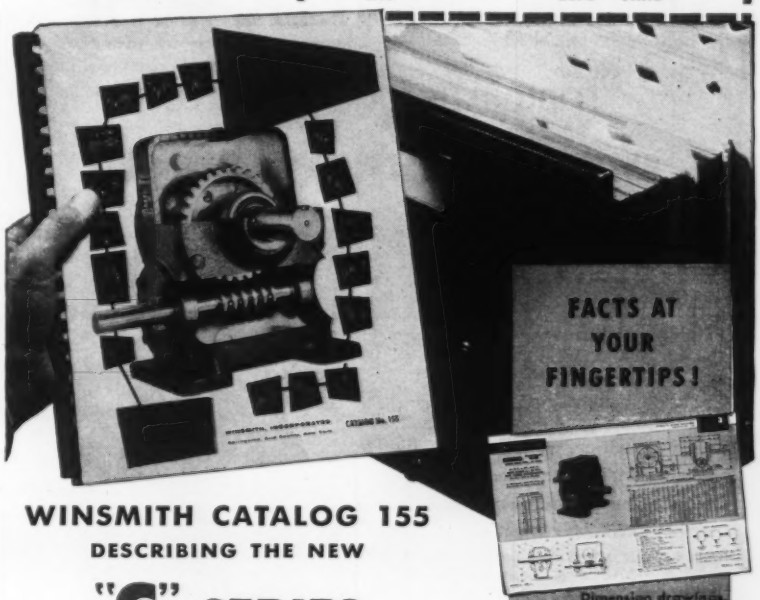
COMPANY

ADDRESS

CITY ZONE STATE


FACTS AT YOUR FINGERTIPS!
Dimension drawings, parts list, shaft arrangements and table of weights are on facing pages for convenience in working. Opens flat on desk or drawing board.
Ratings are given in easy-to-read form . . . arranged in sections so they can be located instantly.
Engineering "Handbook" Section is well illustrated and contains informative test material. Designed to help you solve application problems.

WINSMITH CATALOG 155
DESCRIBING THE NEW
"C" SERIES
SPEED REDUCERS

Between the covers of this new catalog, every design engineer and speed reducer user will find the answer to how they can select speed reducers of more compact dimensions to achieve required output.

With this newly designed "C" Series, Winsmith has succeeded in increasing horsepower and torque output, and increasing the ruggedness of the units *without increasing overall size.* In all, 108 models in single and double reduction are available within the range of .01 to 34 hp; in a ratio range of 5:1 to 4460:1 and in an output torque range of 142 in. lbs. to 34,767 in. lbs. The complete "C" Series plus a number of other popular models in the Winsmith line are catalogued for your working convenience.

FOR YOUR COPY OF
CATALOG 155 FILL IN AND
MAIL THE COUPON
TODAY!

WINSMITH
SPEED REDUCERS

...a single source for the most complete line of speed reducers within the range of 1/100 h.p. to 85 h.p. in ratios of 1.1:1 to 50,000:1

WINSMITH, INC.
16 Elton Street
Springville, (Erie County), N. Y.

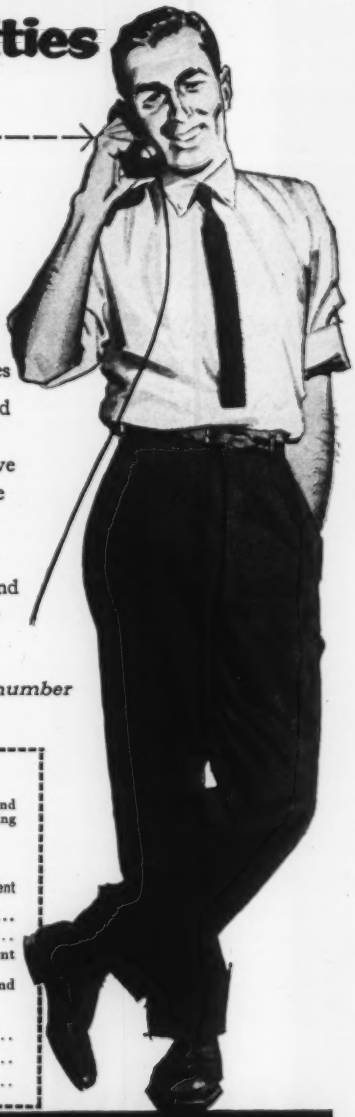
Circle 518 on page 19

# Designers

## OPERATION TELEPHONE

may introduce you to

**unusual advancement opportunities**



Across the nation, we have talked by phone with men who have expressed interest in our design work. Easily, quickly they have been able to get the important facts on our attractive career opportunities

If *you* are restless — perhaps in a deadend job — mail the coupon *immediately*. Chances are we will call you shortly — give you an opportunity to verbally investigate what we have to offer.

Ability shows up fast in our design work. Some of our top men, with top earnings and responsibility, are comparatively young. It could happen to you.

***Be sure to give us your home telephone number***

Mr. E. M. Peterson, Dept. 4, Design Employment
Pratt & Whitney Aircraft, East Hartford, Conn.

I would like to learn more about your openings for product and component designers. My experience has been in the following fields:

| | | |
|---|---|---|
| ☐ Nuclear Design | ☐ Aerodynamics | ☐ Bearings |
| ☐ Compressors | ☐ Hydraulics | ☐ Piping |
| ☐ Turbines | ☐ Gears | ☐ Controls |
| ☐ Structures | ☐ Valves | ☐ Test Equipment |
| ☐ Afterburners and Related Equipment | ☐ Heat Exchangers and Combustion Problems | ☐ Test Rigs |

Total years Mechanical Design experience .....

You can reach me at ..... Most convenient (home telephone) hours for receiving calls are between .....and .....

NAME .....

HOME ADDRESS .....

CITY .....STATE .....

**PRATT & WHITNEY AIRCRAFT**

DIVISION OF UNITED AIRCRAFT CORPORATION, EAST HARTFORD 8, CONNECTICUT

*World's foremost designer and builder of aircraft engines*


# MEN

## OF MACHINES

The appointment of **E. M. Estes** as chief engineer of the Pontiac Motor Div. has been announced by General Motors Corp. Mr. Estes was a student at General Motors Institute before earning his college degree in mechanical engineering. He joined the GM Research Laboratories as a research engineer in 1939, became motor development engineer in the Oldsmobile Div. in 1946, then advanced to assistant motor engineer and chassis engineer. Mr. Estes was named body engineer in 1952 and was promoted to assistant chief engineer in charge of the body design, chassis design and standards engineering groups in May, 1954.

E. M. Estes

**John F. Zubrod** has been appointed product manager of the air conditioning division of Whirlpool-Seeger Corp., St. Joseph, Mich. Mr. Zubrod was associated with the commercial refrigeration division of Servel Inc. for 23 years.

Illinois Tool Works, Chicago, has appointed **Donald P. Ridgeway** to the newly established position of manager of the Spiroid Department. His responsibilities will in-

clude engineering, production and sales of Spiroid gears. Mr. Ridgeway was formerly vice president of engineering and sales for Janette Electric Mfg. Co.

**V. H. Peterson** has been named to the position of vice president in charge of engineering by Fairbanks, Morse & Co., Chicago. **Gordon Anderson Jr.** has been transferred to the office of the vice president in charge of engineering as assistant chief engineer of the company.

**Chester P. Coldren** has been named manager of research and development of the Reliance Div. of Eaton Mfg. Co., located in Massillon, O. He will have charge of

Chester P. Coldren

engineering research and development of products, production methods and equipment. Associated with the company for 15 years, Mr. Coldren has been assistant manager of research and development since 1950.

**Thomas J. May** has been appointed supervisor of the engineering analysis group at Weber Aircraft Corp., Burbank, Calif.

Progressive Welder Sales Co., Detroit, has appointed **Peter D. de Leo** as engineering consultant. Mr. de Leo joined the company in 1945 as head of the Experimental

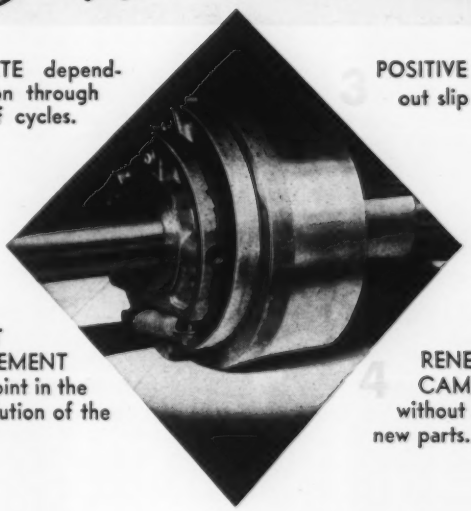

HILLIARD CLUTCHES FOR POWER CONTROL DESIGNS

HILLIARD

*Single Revolution* CLUTCH

ACCURATE dependable action through millions of cycles.

POSITIVE motion without slip or lag.



INSTANT ENGAGEMENT at any point in the the revolution of the driver.

RENEWABLE CAM SURFACES without machining or new parts.

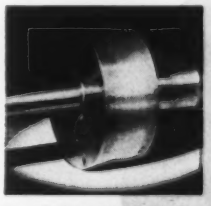
The Hilliard Single Revolution Clutch *is automation* because it provides precise accurate intermittent motion automatically. Control can be electrical or mechanical.

The use of Hilliard Single Revolution Clutches has improved the operation of tube straightening and cut-off machines—shears—conveyors—riveting and fastening units—case loaders—bottle unscramblers—weighing and packaging—indexing and feeding—marking—punching—textile and business machines—radar apparatus—proportionate pumps—and many other types of mechanisms.

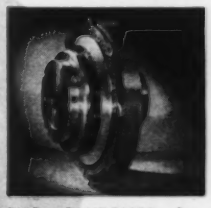
WRITE TODAY FOR BULLETIN 239 WITH COMPLETE INFORMATION.

• OTHER HILLIARD CLUTCHES •

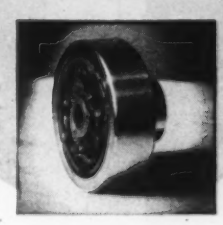
*CONSIDER AUTOMATION - INVESTIGATE THESE PRODUCTS*



HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.



OVER-RUNNING CLUTCHES for automatic instantaneous engagement and release on two speed drives, dual drives and ratchet or backstop action. Ask for Bulletin 231.



SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

THE HILLIARD CORPORATION

MANUFACTURING CLUTCHES FOR OVER 50 YEARS

103 W. FOURTH ST. ELMIRA, NEW YORK

IN CANADA: UPTON • BRADEEN • JAMES, LTD.


Circle 519 on page 19

FILL OUT COUPON
FOR FACTS, SAMPLES!

ALUMINUM COMPANY
OF AMERICA
2244-K Alcoa Bldg.
Pittsburgh 19, Pa.
Gentlemen:
Please send complete specification data
and samples of your aluminum fasteners.
Name
Title
Company
Address

Always fasten aluminum with
ALCOA
Aluminum
Fasteners
available at your local ALCOA distributor

ALCOA ALUMINUM
FASTENERS

Circle 520 on page 19

## Men of Machines

Department and for many years has been chief electrical engineer.

**B. I. Ulinski** has been appointed director of development and design by Automatic Transportation Co., Chicago. He will direct an enlarged staff that will be housed

B. I. Ulinski

in a new addition now under construction.

The company also announced the appointment of **Raymond E. Orton** as manager of the product engineering department. Mr. Orton was general manager and chief engineer of Orton Crane and Shovel Co. and has previously served as chief engineer of Acme

Raymond E. Orton

Steel Co., and as special engineer at International Harvester Co. He has written a number of articles for MACHINE DESIGN.

**James C. Zeder** was recently appointed special adviser to the president of Chrysler Corp., and **Paul C. Ackerman** was elected a corporation vice president. Mr. Zeder is vice president of engineering and a director of the company. Mr. Ackerman is director of engineering.

**Lionel Glauberman** was recently appointed assistant chief engineer at Assembly Products Inc., Chesterland, O. He joined the company two years ago.

**Seth H. Stoner** has been named chief engineer and **Frederick J. Garbarino,** director of quality control for the New Departure Div. of General Motors in Bristol, Conn. Mr. Stoner joined the company as a junior engineer with GM Research in Detroit. He has been associated with the New Departure Div. since 1955. Mr. Garbarino, who also joined the New Departure Div. in 1935, has been chief engineer since 1951.

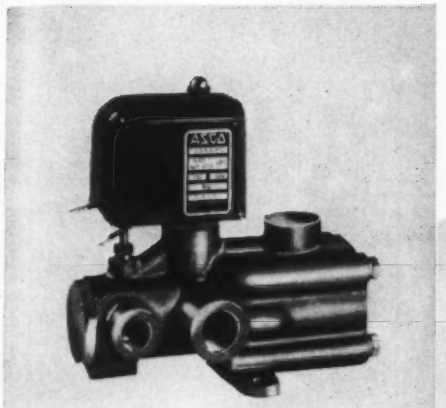
Previously senior project engineer, **Joseph Swanson** has been named assistant to the chief engineer at Levinthal Electronic Products Inc., Redwood City, Calif.

The appointment of **William Willis** as engineering manager has been announced by Marman Products Co. Inc., Los Angeles.

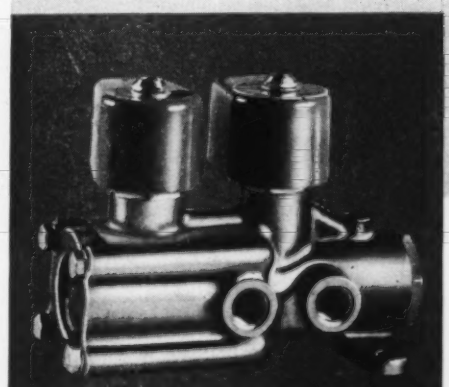
**Harold W. Rice** has been appointed director of the West Coast Research & Development Laboratory of Robertshaw-Fulton Controls Co. The laboratory is located in Los Angeles. Mr. Rice has been associated with the company for more than 20 years and has been project supervisor at the West Coast laboratory since 1951.

**R. R. Allen** has been named vice president and director of engineering and research by John Wood Co., New York.

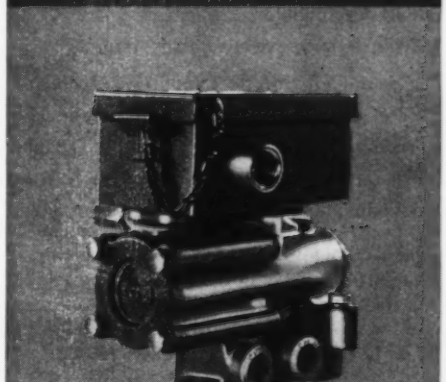
# Now available: full line of ASCO 4-way solenoid valves



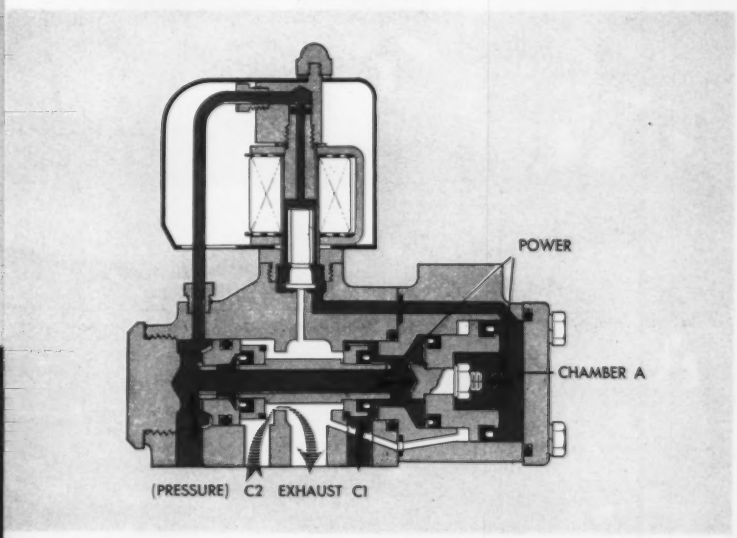
**Single Solenoid:** operates when solenoid is energized; returns automatically when de-energized.



**Dual Solenoid:** operates when either solenoid is energized; will not return until opposite solenoid is energized. Solenoids may be energized continuously or momentarily.



**J.I.C. Construction:** single and dual solenoids, with sub-plate mounting.




## power driven in both directions by line pressure

Now available in ⅜" through 1" sizes, these valves are positive in action. When the solenoid is de-energized, *line pressure* applied to the top of the pilot core forces it off the seat, eliminating possible sticking caused by residual magnetism. *Line pressure* is applied to Chamber A, moving the piston-disc assembly to the left. When the solenoid is energized, Chamber A is exhausted and *line pressure* drives the piston to the right.

## absolutely tight seating — no leakage

Combination of metal to metal and resilient seating provides dead tight shut-off – even on air. No grinding, lapping or close adjustments are necessary.

Available in standard, watertight or explosion-proof solenoid enclosures, the Bulletin 8344 permits cycling rates to 850 per minute – mounted in any position. Design simplicity eliminates maintenance problems.

### J.I.C. construction available

These 4 way valves are available in all sizes to meet J.I.C. (Joint Industry Conference) standards. Valves are provided with sub-plates, vapor-proof solenoid enclosures, and manual overrides, and are electrically inoperative when the cover is removed.

New ASCO Condensed Valve Catalog No. 201 is now available. Write today for this basic reference on solenoid valves.

**Important announcement** . . . *new ASCO plant now being built in Florham Park, N. J., will double production capacity and greatly extend the range of our research, product development and services.*

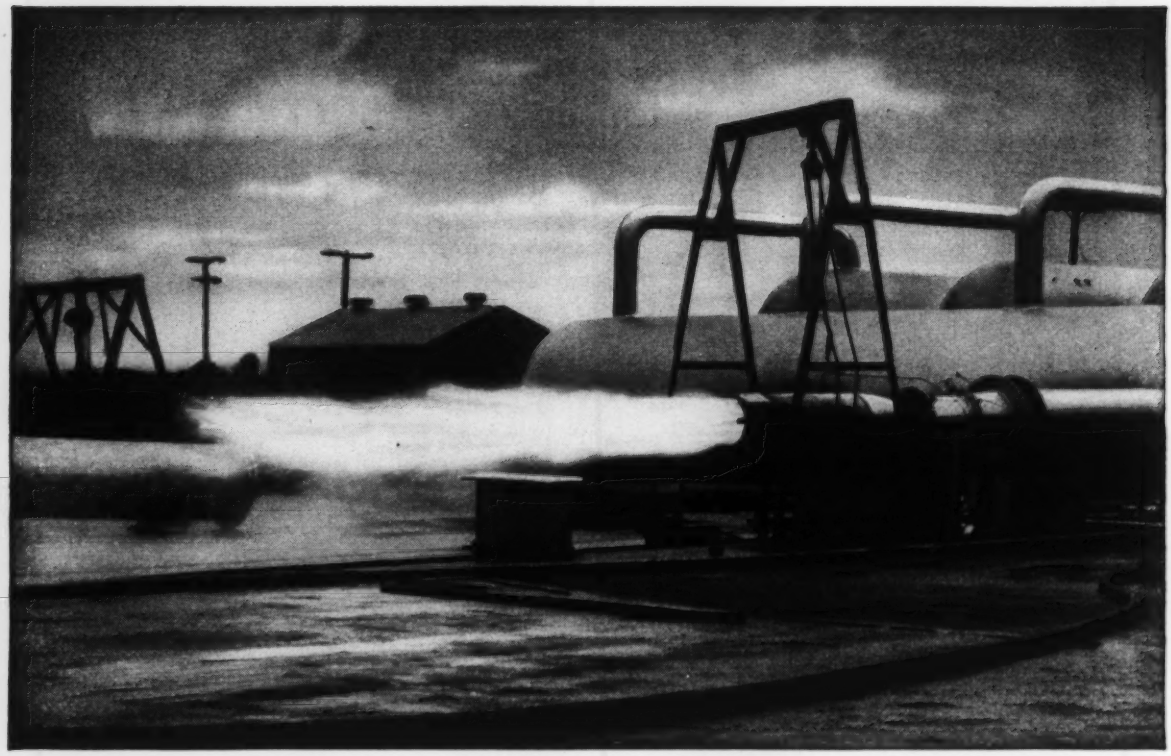
AUTOMATIC TRANSFER SWITCHES
SOLENOID VALVES ELECTROMAGNETIC CONTROL

Automatic Switch Co.
387 Lakeside Avenue, Orange, N. J. • ORange 2-5300

ASCO



Circle 321 on page 19



Ramjet tailpipes withstand severe abuse. (*Photo courtesy Marquardt Aircraft Company*)

# MULTIMET Alloy Controls the Blast of Ramjet Engines

Tailpipes used to direct the searing blast of power in today's ramjet engines must withstand temperatures in excess of 2000 deg. F, plus severe vibration. High-speed ramjets operate in the neighborhood of 1500 mph. At these high speeds, vibration is almost as serious a threat to tailpipe life as heat. Because of its strength at high temperatures, MULTIMET alloy has given good service in tailpipes that vibrate as much as three inches.

Ramjet tailpipes are made of MULTIMET alloy sheet that is only 0.051 to 0.078 in. thick. The combined high-temperature strength and oxidation resistance of MULTIMET alloy permits the use of lightweight tailpipes with good heat-transfer properties.

MULTIMET alloy is one of many HAYNES alloys capable of extending the life of parts used at high temperatures. For literature describing the properties of HAYNES high-temperature alloys, get in touch with the nearest Haynes Stellite Company Office.

HAYNES TRADE-MARK ALLOYS

**HAYNES STELLITE COMPANY**

**A Division of Union Carbide and Carbon Corporation**

UCC

General Offices and Works, Kokomo, Indiana

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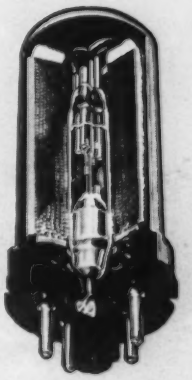
Chicago • Cleveland • Detroit • Houston • Los Angeles • New York • San Francisco • Tulsa

*"Haynes" and "Multimet" are registered trade-marks of Union Carbide and Carbon Corporation.*



Circle 522 on page 19

# It will take still more years of testing –at 1.89 x $10^9$ operations a year– to fix the life span of this relay



*When we first claimed a life of a billion operations for* CLARE *Mercury-wetted Contact Relays, we were guilty of a serious understatement.*

## *Here is the proof:*

A life test was started in January, 1955. The relays on test are carrying a contact load of 5 amperes at 50 volts d-c (resistive load). A suitable spark suppressor is employed.

These relays have been operating continuously at a rate of 5,184,000 operations a day ever since, without any attention whatsoever.

As this is written they are closely approaching the 3 billion mark, with every indication they will go on operating for years.

*Think of it! Here is a relay that in normal service will outlast a man's lifetime!*

**Have you a job for which none but the best relay is good enough? It can cost you much more to settle for less than this CLARE RELAY.**

**Price is reasonable. Prices for Multi-element Mercury-wetted Contact Relays have recently been reduced. Delivery is quick—a few days to a few weeks, depending on assembly desired and size of order.**

**FOR COMPLETE INFORMATION** on CLARE Mercury-wetted Contact Relays for single or multiple circuits contact your nearest CLARE representative or address: C. P. CLARE & Co., 3101 Pratt Blvd., Chicago 45, Illinois. *In Canada:* C. P. CLARE & Co., 659 Bayview Avenue, Toronto 17. Cable address: CLARELAY.

**Send for CLARE Sales Engineering Bulletins Nos. 120 and 122**

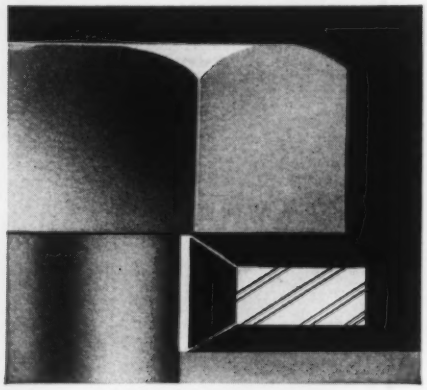
# CLARE RELAYS

**FIRST in the industrial field**

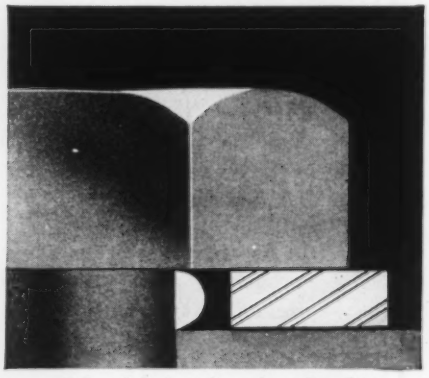
*Circle 523 on page 19*

***Another new development using***

# B.F.Goodrich Chemical *raw materials*



*Seal before compression*



*When bolt is tightened, sealing lips are forced against surface.*

## Hycar rubber bonded to steel solves sealing problems

FACED by a sealing problem with water, gases, chemicals, petroleum products or other fluids? Then listen to this:—

The Precision Rubber Products Corporation of Dayton, Ohio, has come up with a one-piece seal using Hycar nitrile rubber that gives positive sealing action against constant or pulsating pressures up to 10,000 psi!

The Hycar is heat and pressure-bonded to a steel washer to become the sealing member. When compressed, it supplies lock washer action and reduces bolt torque. Under any type of flange, bolt or screw, it gives leak-proof sealing. What's more, it eliminates costly groove cutting or machining of surfaces.

Hycar was specified for this new product because it keeps its shape, strength and flexibility . . . is far superior to general purpose rubber in resistance to oxidation and aging. And it has exceptional resistance to the deteriorating properties of a wide range of fluids and gases, temperatures and pressures.

Throughout industry, Hycar's remarkable qualities are improving existing products or are providing the inspiration to create new products. For complete information on how one of the Hycar rubbers can do this for you, too, write Dept. EJ-5, B. F. Goodrich Chemical Company, 3135 Euclid Ave., Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

**Hycar**
Reg. U.S. Pat. Off.
*American Rubber*

**B. F. Goodrich Chemical Company**
**A Division of The B. F. Goodrich Company**

**B.F.Goodrich** **GEON polyvinyl materials • HYCAR American rubber and latex • GOOD-RITE chemicals and plasticizers • HARMON colors**

**YOU'LL FIND G.S. GEARING IN TOP QUALITY PRODUCTS LIKE THESE...**

Adding Machines • Aircraft Instruments and Radios • Automatic Musical Instruments • Business Machines • Check Signing & Protecting Machines • Clippers for Barbers, Animal Shearing & Hedge Trimming • Cloth Cutting Machines • Coin Changers & Counters • Communication Equipment • Electric Fans • Electric Motors • Floor Polishers, Sanders, Scrubbers, Sweepers • Food & Drink Mixers, Blenders • Home Appliances • Lawn Sprinklers • Machine Tools • Meat Tenderizers, Grinders, Slicers • Military Equipment • Motion Picture Cameras & Projectors • Outboard Motors • Pneumatic Production Tools • Portable Electric Tools • Radio & Radar Tuning Assemblies • Radio Anti-backlash Gears • Record Changers • Sewing Machines • Steel Strap Stretchers • Step Switches • Tapping, Drilling & Threading Equipment • Telephone Dials • Television Sets • Thermostatic Controls • Typewriters • Vending Machines • Washing Machines.

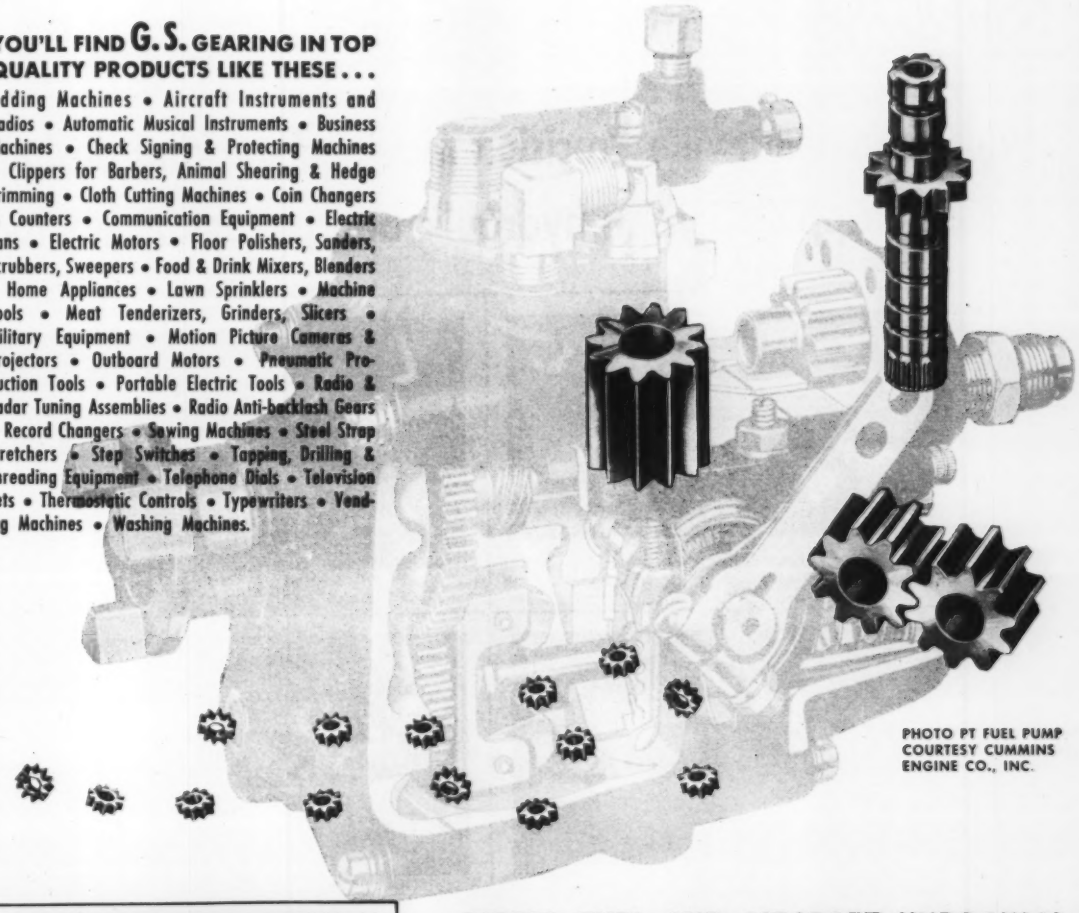


PHOTO PT FUEL PUMP COURTESY CUMMINS ENGINE CO., INC.

GEAR
Specialties, Inc.
2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS

SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARING

## DIESEL FUEL AND AIRCRAFT HYDRAULIC SYSTEMS ARE MORE DEPENDABLE WITH G. S. SMALL GEARING

GEARING for Diesel Fuel and Aircraft Hydraulic Systems must measure up to the most rigid quality standards. Occasionally, a single, intricate component requires 40 or more extremely accurate operations. You see, Pump Gearing must function *without fail*, under *all* operating conditions. Utter dependability is essential. ★ G.S. Small Gearing is usually specified for mechanisms that perform perfectly *always*. Will YOU also join the fast-growing group of critical customers who come to "Headquarters" for *all* the Small Gearing they need? You'll find it pleasant and *profitable* to do this.

***SEND FOR FREE*** *6-page Small Gearing Guide. It describes 80 types and applications. Contains useful charts . . a valuable aid to anyone interested in Small Gearing. Use company letterhead, please. No obligation, of course. Write today!*

FRACTIONAL HORSEPOWER GEARING

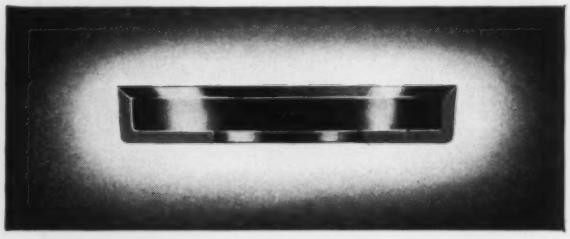
*40 Years of Specializing in Small Gearing!*



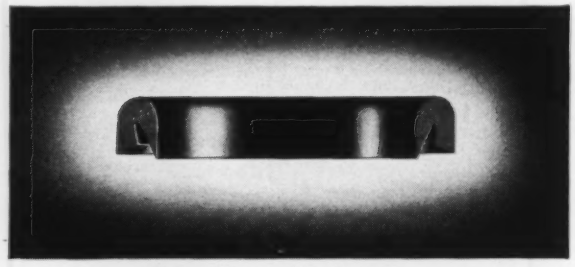
Circle 525 on page 19

# *Simplify your sealing problems...*

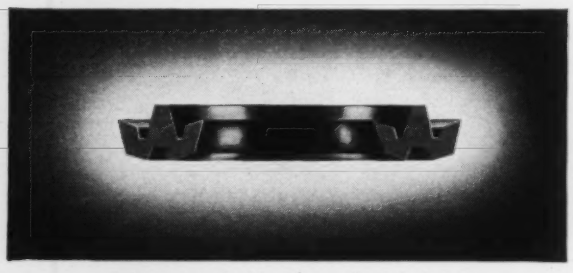
## with Johns-Manville Precision moulded packing designs for pressure applications in hydraulic and pneumatic equipment



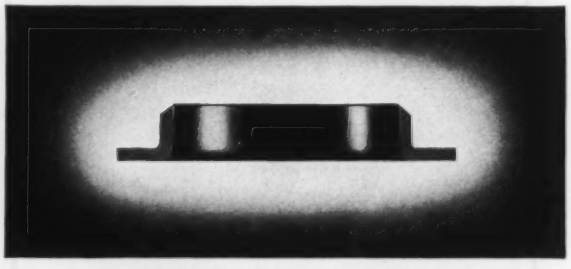
**1.** Type "A" Packing Cups for pistons
*(the original "square heel" cup design)*



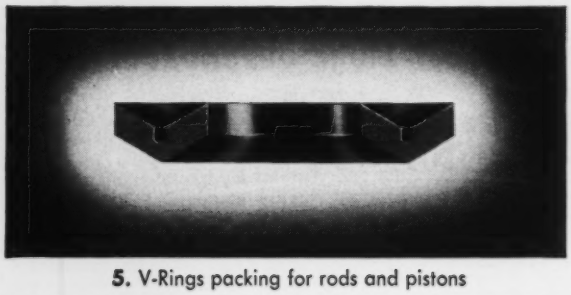
**2.** Sea Ring packing for rods



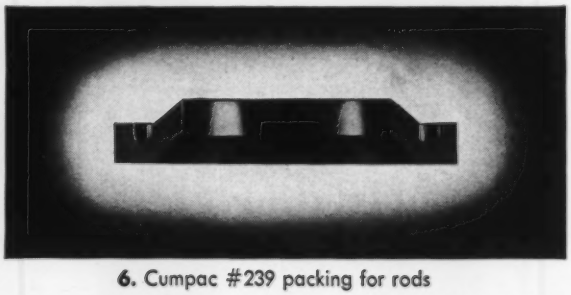
**3.** Uneepac Packing for rods and pistons



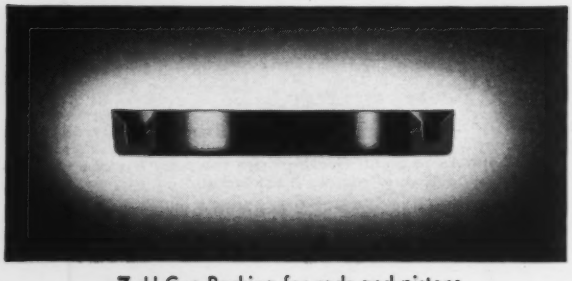
**4.** Hat Cup Packing for rods



**5.** V-Rings packing for rods and pistons



**6.** Cumpac #239 packing for rods



**7.** U-Cup Packing for rods and pistons

THE WIDE VARIETY of Johns-Manville Packing designs enables you to handle practically any sealing problem. The designs shown on this page are obtainable in a broad range of standard sizes and in materials designed for either usual or special service conditions encountered in hydraulic and pneumatic equipment. Johns-Manville also produces oil seals, moulded gaskets and miscellaneous shapes to specification. See your local J-M distributor or J-M sales office for product or engineering data. Or write Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

**Johns-Manville MOULDED PACKINGS**



Circle 526 on page 19

# "FOUR!"

***Four?*** **That's right. Look closely, you'll notice this little golfer represents all four of the services available to designers from Sylvania's Parts Division: (1) Custom-molded plastics; (2) Plated, clad and alloy wire; (3) Metal stampings; (4) Electronic components.**

All of these parts were supplied in quantity to just one major manufacturer during the past year. On many of these items, Sylvania representatives were called in for consultation before parts designs were finalized. Suggestions from an experienced parts producer can often reduce costs, increase efficiency, and assure more uniform production in high volume items.

Manufacturers who insist on the highest degree of quality and efficiency can find Sylvania's 4-way service extremely helpful. For complete details write for the "Portfolio of 4-way Service to Designers." Address Dept. K52S.

**SYLVANIA** PARTS DIVISION

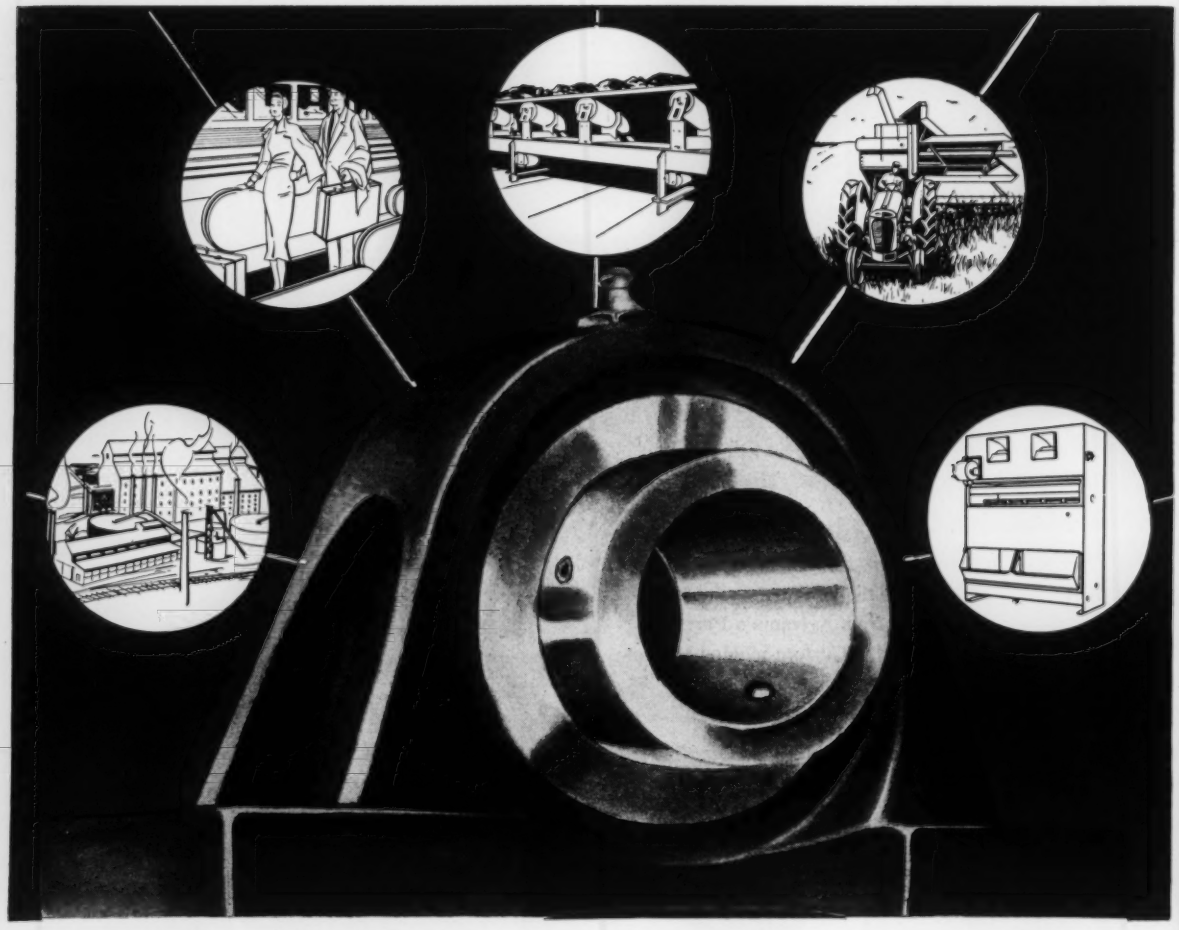
Sylvania Electric Products Inc., Parts Division, Warren, Pennsylvania

SPECIAL WIRE | METAL STAMPINGS | MOLDED PLASTIC | ELECTRONIC COMPONENTS

4-way service from one source



Circle 527 on page 19



# SEALMASTER

## has an important bearing on the performance of machinery you build!

Whether you manufacture farm machinery, air conditioners, textile machinery, conveyors, machine tool equipment, or road machinery, the exclusive combination of features found in SEALMASTER Bearing Units are important to you! One of the most significant trends in industry today is the increased concern for quality. Production schedules can't be kept up when machinery is down for maintenance. No component you build into your product will mean more to its efficient performance than the bearing units carrying the load. You'll want full information on SEALMASTER'S exclusive combination of features and what they mean to the performance of your products.

**Bulletin 454 should be in your files.**

**Write for it today!**



**SEALMASTER BEARINGS** A DIVISION OF STEPHENS-ADAMSON MFG. CO., 18 RIDGEWAY AVENUE, AURORA, ILLINOIS



*Circle 528 on page 19*

*Circle 529 on page 19→*

**Synchronous Speed with Induction Simplicity**

# NEW *Synduction* Motor

## MORE

### Motor Pioneering by Allis-Chalmers makes constant speed sure and inexpensive

Constant speed from no load to pull-out regardless of load and voltage fluctuations . . . simple across-the-line control . . . fixed speed ratios for a group of synchronized drives . . . high power factor . . . high efficiency — every one of these characteristics is included in the greatest motor design advance in years, the *SYNDUCTION* MOTOR.

Here is a motor that combines the simple dependability of squirrel-cage construction with the constant speed advantage — and none of the complications — of other types of synchronous designs.

Available in all squirrel-cage enclosures and in ratings from ¼ to 40 hp, the *Synduction* motor means new operating economies at lower initial cost in many industries.

*Synduction* is an Allis-Chalmers trademark.

**Have You An Application Requiring:**

1. unvarying speed; 2. operation of several motors at fixed speed ratios; 3. adjustable speed with minimum variation at any speed setting? If so, Allis-Chalmers invites your inquiry. Contact your nearby A-C office or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis., for Bulletin 51B8440.

A-C ALLIS-CHALMERS

A-5110

# ALLIS-CHALMERS

ALLIS-CHALMERS

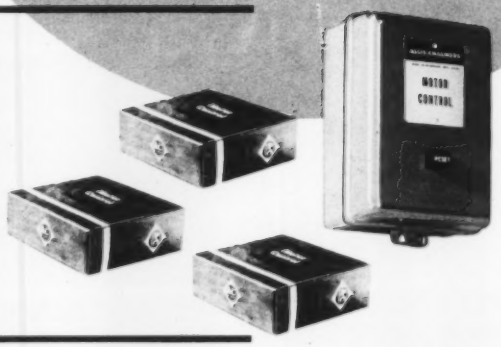
# MOTOR CONTROL

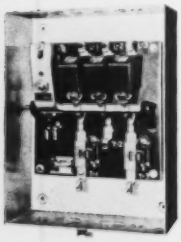
## a Complete Line

### SIZE 0-3 STARTERS

*Converta-Kits* Permit Easy Modification of Basic Starter

You get MORE . . . more flexibility with Allis-Chalmers control. A screwdriver and the proper *Converta-Kit* are all you need to change a basic Allis-Chalmers size 0-3 starter into the exact unit demanded by your production. *Converta-Kits* are available for push-button, selector switch and electrical interlock modifications. Starter replacement parts—contacts, magnetic coils and overload relays —are also available in packaged kits.



1. Arc across contacts as they start to open.
2. Strong blowout action forces arc to center.
3. Contacts fully open — arc extinguished.

### NEW LINE OF SIZE 4-5-6 STARTERS

Quick Quenching Extends Contact and Chute Life

Heart of these starters is a new contactor which uses a revolutionary principle of arc interruption. In centering the arc, increased blowout action and fast quenching result from a combination of thermal convection and magnetic action. Since the arcing time is sharply curtailed, contact and chute life are greatly extended.

### HIGH VOLTAGE STARTERS

Complete "Line-to-Load" Control and Protection

Allis-Chalmers Type H starters are built in a wide range of ratings for squirrel-cage, wound-rotor and synchronous motors . . . for full or reduced voltage — reversing or non-reversing — with plugging, dynamic braking and multi-speed features. Built into the starter is the type and degree of protection dictated by the application.

### What is your control problem?

As manufacturers of a diversified line of industrial equipment, Allis-Chalmers has solved thousands of control application problems. This specialized experience is yours when you specify Allis-Chalmers control. See your Allis-Chalmers representative or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

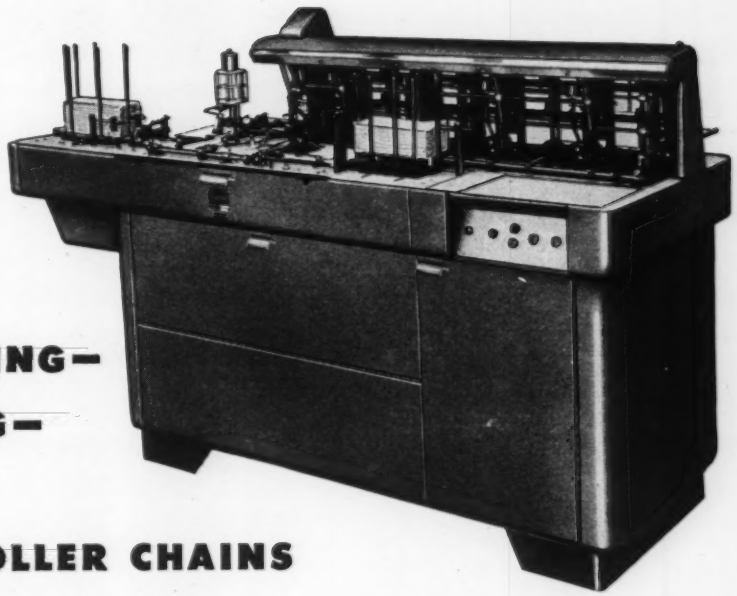
*Converta-Kit* is an Allis-Chalmers trademark.

A-C ALLIS-CHALMERS

A-4988

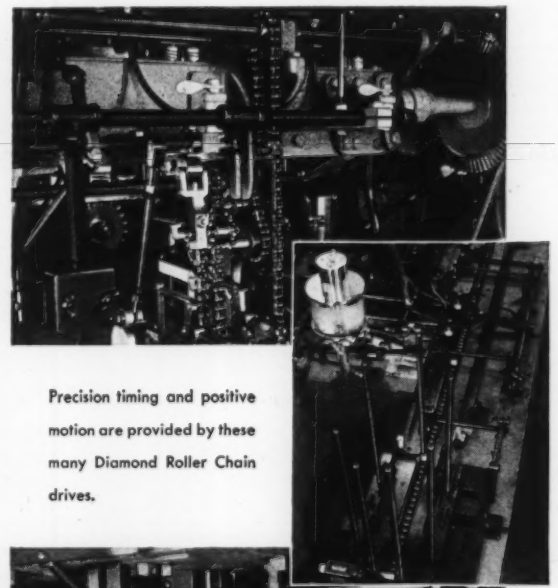
# ALLIS-CHALMERS

*Inserting and Mailing Machine Company "Finished Machine"—4, 6 or 8 insert—envelopes from 3½ x 6½ to 6 x 9½.



# PRECISE TIMING—
# ACCURATE CONVEYING—
# PERFECT HANDLING—

## *all jobs for*
## DIAMOND ROLLER CHAINS



Precision timing and positive motion are provided by these many Diamond Roller Chain drives.

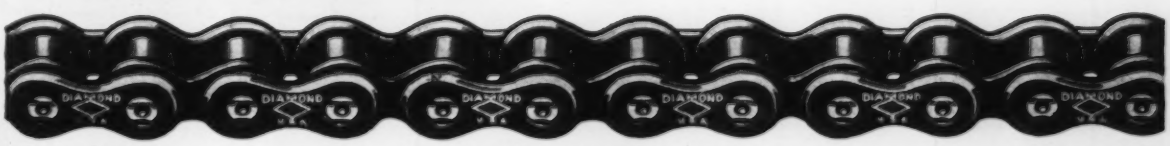
Contributing to the swift precision handling of envelopes and stuffers by this inserting and mailing machine* are many Diamond Roller Chain drives. They transfer power from shaft to shaft, operate cams, convey, change speeds, provide rotating and reciprocating motions.

For your machinery, too, Diamond Chain can provide the solution to many drive problems. You can have lightweight *precision* drives regardless of shaft center distances, *positive* power drives that deliver 98-99% efficiency and provide longer life with minimum maintenance.

Call on Diamond Engineers now. Their knowledge and experience are at your service. Catalog 754 with valuable tables and data is available on request.

**DIAMOND CHAIN COMPANY, Inc.**
*Where High Quality is Traditional*
**Dept. 435, 402 Kentucky Ave., Indianapolis 7, Indiana**
*Offices and Distributors in All Principal Cities*

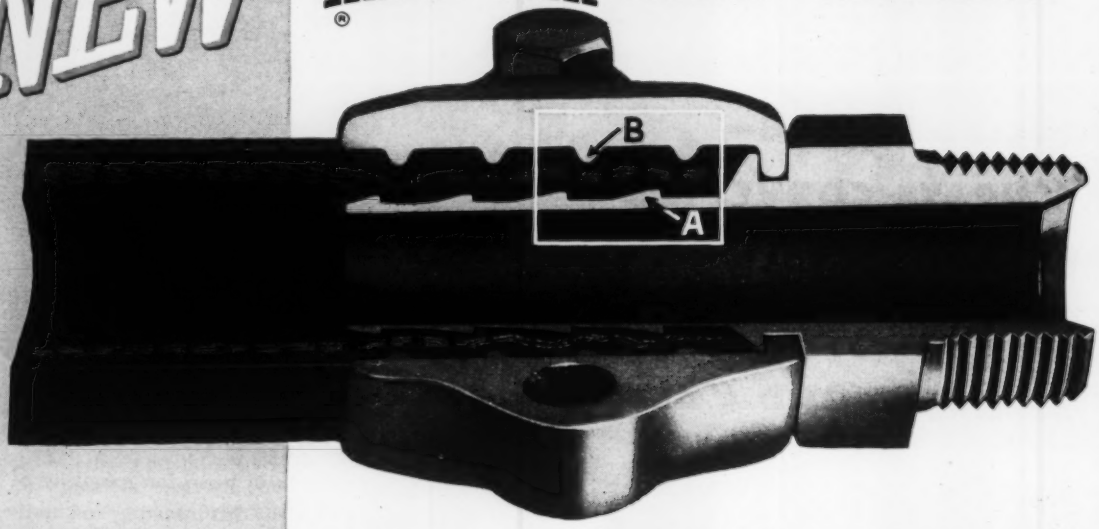
DIAMOND ROLLER CHAINS





Circle 530 on page 19

# NEW Eastman INTER-LOCK® CLAMP COUPLING




EASTMAN MFG. CO. announces its New **Inter-Lock** Clamp Coupling—offering *exclusive grip advantages* available in no other coupling of its type.

## EXCLUSIVE EASTMAN INTER-LOCK FEATURES

Eastman's New **Inter-Lock** Clamp Coupling provides positive positioning through accurate machining of clamp and insert—as the outside rib of the clamp is locked between the collar and hex of the insert, before tightening.

The accurate location of the clamp over the insert assures alternate mating of the barbs of the insert (A) with the circular ribs of the clamp (B).

Hose is uniformly compressed into each alternating recess—increasing the holding power of the Clamp Coupling—thereby creating **Eastman's Exclusive Inter-Lock Grip.**

Longer service is assured because hose construction is not weakened by pinching, as it may be if ribs and barbs were permitted to fall directly opposite each other.

EASTMAN'S Exclusive **Inter-Lock** feature is another example of advanced design and engineering which gives you greater value, plus the *all-important competitive advantage* of superior product performance and customer satisfaction in the field.

Look to EASTMAN . . . *first in the field* of Hydraulic Hose Assemblies . . . for continued leadership in design and engineering—plus the highest quality material and workmanship.

**STANDARD INSERTS FOR EASTMAN INTER-LOCK CLAMP COUPLING**

For low, medium and high pressure hose up to 5000 psi. working pressure. Available for hose sizes ranging from ¼" to 2" I.D.—according to pressure requirements. Also available for angle and straight tube applications.

SWIVEL FEMALE

MALE PIPE

MALE FLARE

INSERT FEATURE
Beveled shoulders of barbs permit easy insertion into hose.

*WRITE* for Standard Sizes or send your blueprints and specifications.

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

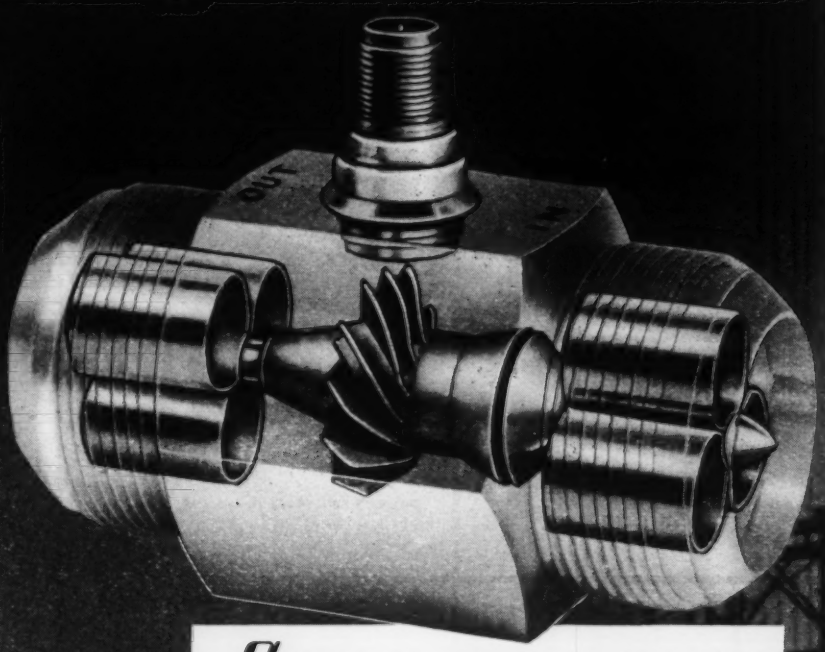
**Eastman** *first in the field*

MANUFACTURING COMPANY
Dept. MD10, Manitowoc, Wis.



Circle 531 on page 19

# Taming corrosive rocket fuels



## *Carpenter* Stainless No. 20 controls flow of liquid oxygen, red fuming nitric acid

Vital parts of these flow sensing units must have extreme corrosion resistance and durability. Machined from Carpenter Stainless No. 20 bar stock, they measure the flow of liquid oxygen and red fuming nitric acid (90-98% concentration). The No. 20 parts have outlasted two Type 316 housings. The units are so rugged that rocket experts recover them from wrecked missiles for re-use.

Similar units also measure the flow of oil to industrial furnaces, gases, slurries and other corrosive fluids at rates of .09 to 3000 gpm. They operate from 1000°F down to temperatures approaching absolute zero, and at pressures up to 35,000 psi.

If you design, build or use equipment that must withstand corrosive attack, discover how Stainless No. 20 and No. 20Cb can save you money. Eight different forms—bars, billets, pipe, plate, sheet, strip, tubing and wire—of these super-corrosion resistant alloys are available from . . .

MEMBER

**The Carpenter Steel Company, Alloy Tube Division, Union, N. J.**

*Export Dept.: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"*

**Carpenter**

**Stainless No. 20**

**Carpenter No. 20 bars, strip, wire and billets are available also from The Carpenter Steel Company, Reading, Pa.**

Ad #1-57
October 4, 1956

Circle 532 on page 19

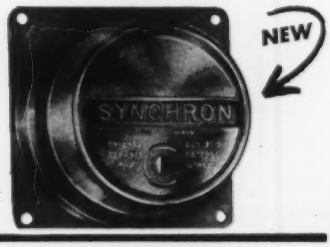
# THE POWER-RATED SYNCHRON LINE / A TIMING MOTOR FOR EVERY JOB

### 8 IN. OZ. TIMING MOTOR

Widely used in timing machines, time switches, heating and air conditioning controls, action signs, recording thermometers, and other timing devices. Guaranteed to pull 8 in. oz. direct load continuously at 1 r.p.m.

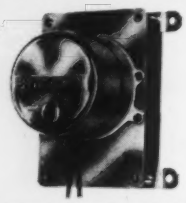
### 20 IN. OZ. TIMING MOTOR

Ideal for timing motor applications requiring continuous high torque power. Instant starting, dependable accuracy, and flexible installation. Call for Synchron's guaranteed 20 in. oz. at 1 r.p.m. power when your job calls for long, continuous torque.




### 1 R.P.H. TIMING MOTOR

Guaranteed to pull 20 in. oz. at 1 r.p.h. (1/60 r.p.m.) Synchron's especially developed motor for slow motion timing applications. Eliminates need for extra reduction gears between 1 r.p.m. and 1 r.p.h. in intermittent time trains. Gives gear train with lifetime lubrication; enclosed and trouble-free.

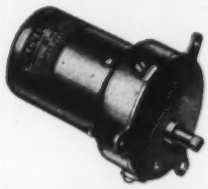


### SYNCHRON TIMING MACHINES

An almost unlimited number of shaft speeds. Synchron Motor fixed to a rigid frame. Easy to mount and connect in any position. Trouble-free, accurate. Drives everything from liquid recorders to program clocks and washing machine timers. Highlights complete versatility of famed Synchron Line.

### SYNCHRON CLOCK MOVEMENTS

For standard and office clocks, sign clocks, novelty clocks, and clocks of all kinds up to 26" in diameter under glass. Split-second accuracy and long wearing construction, never needs oiling. Furnished with front, rear or bottom set, with or without dustproof case.



### MAGNA-TORC D.C. MOTOR

Designed originally for use in aircraft instruments and radio control mechanisms. During World War Two the Hansen Magna-Torc proved its rugged dependability in all altitudes and in all climatic conditions. Now this motor is being adapted to many commercial applications.

*"Workhorse of the industry"*

*Synchron synchronous motors operate smoothly, evenly in any position; at temperatures from —40° to +140°F.; start instantly under load; pull up to 20 in. oz. at 1 RPM. Available in 42 speeds from 0.8 RPM to 600 RPM.

**Synchron timing motors in all speeds available for prompt delivery**

## SYNCHRON®

SYNCHRONOUS MOTORS, TIMING MACHINES, CLOCK MOVEMENTS, MAGNATORC D.C. MOTORS

## HANSEN MFG. CO., INC.

OUR 50TH YEAR

## Princeton 12, Indiana

FACTORY REPRESENTATIVES: The Fromm Co., 5254 W. Madison St., Chicago, Ill. • R. H. Winslow Assoc., 123 E. 37th St. New York, N.Y. • Electric Motor Engineering, Inc. 8255 Beverly Blvd., Los Angeles 48, Cal. and 3907 Lyon Ave., Oakland, Cal.

# "designed to take hard knocks"

"Our decision was further based on satisfaction we have enjoyed with other BAKELITE materials used in the SoundScriber system. Chief among these is the high quality vinyl plastic used as our recording discs."

The exterior finish of the "SoundScriber 200" portable dictating machine is *designed* just as are the working parts. It's a specially formulated organosol coating based on BAKELITE Brand Vinyl Resins.

As James J. McKeon, general sales manager of SoundScriber Corporation, New Haven, Conn., explains it: "Exterior appearance was a vital consideration, to give the '200' its high-quality look. Then, too, the unit is soundly engineered. It has to be. It's being taken to the far corners of the world by its users. It's being carried by handle, worn over the shoulder, tucked into auto compartments, packed in suitcases and briefcases. It is imperative that the '200' have a tough, abrasion-resistant finish —one able to take the knocks of travel."

Often, the properties that you seek for a product can be more easily attained by special coatings and finishes, and more economically, than by a structural material. Find out more about the unusual jobs done by organosol coatings. Write for the booklet, "BAKELITE Dispersion Resin Coatings," to Dept. UG-103.

BAKELITE BRAND RESINS for COATINGS

**BAKELITE COMPANY,** *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

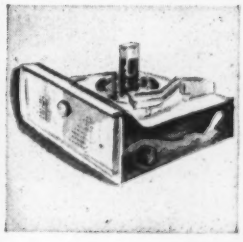
The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC.

Circle 534 on page 19

MONSANTO

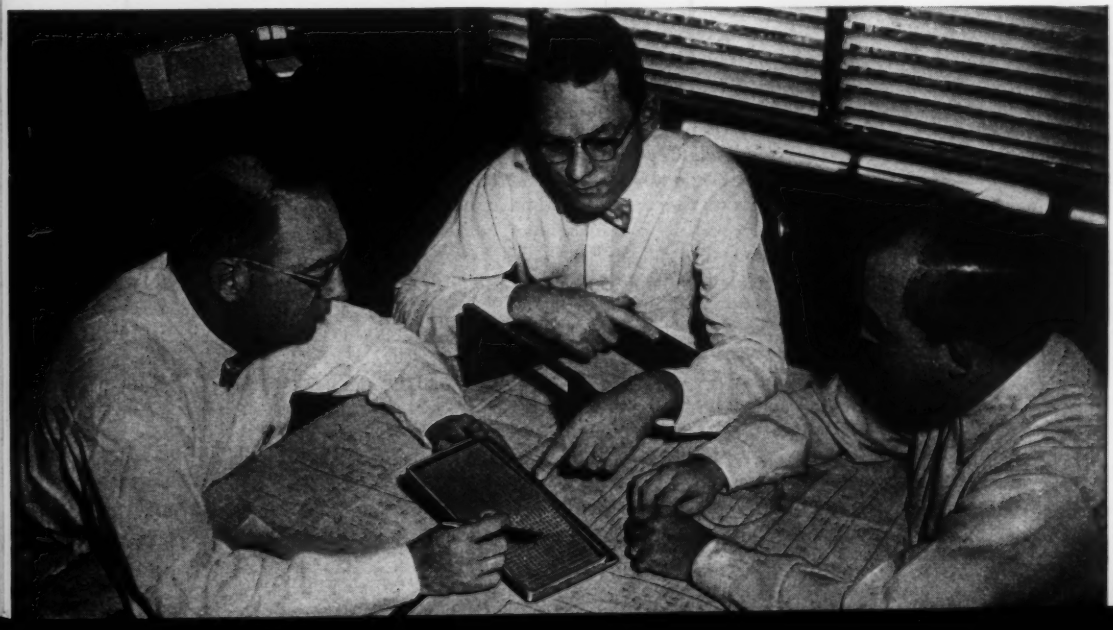
To meet the challenge of making each year's products more serviceable, more saleable than the last, designers in one case after another are enlisting the aid of plastics engineers. This picture-story tells how craftsmen of the custom molding industry utilized the unique properties of plastics to design and fabricate the cabinet for a famous name phonograph.

# Lustrex® styrene builds tough two-tone "home" for new RCA phonograph



**DESIGN OBJECTIVE.** RCA envisioned a one-piece two-colored cabinet—5½" deep, 11" long and 10¼" wide—for its new table model phonograph. It was to be highly durable, low in cost, light in weight, and "custom cabinet-like" in workmanship.

**MATERIAL SPECIFICATIONS.** The assignment was turned over to Cambridge Panelyte Molded Plastics Company, Cambridge, Ohio. Working from a wooden mock-up, these custom molders arrived at one immediate conclusion: there was no practical way to mold the base and grill as a single unit—and still control the duality of color specified by RCA. This meant that, added to other material specifications, there was the need for a material that would allow solvent-cementing assembly of the two parts. Other points to be considered in the selection of the right material included intrinsic hardness, fracture potential in movement, finish, moldability into intricate involutional patterns, and color choice. This last requirement pointed directly to styrene which was found to be completely adaptable to the unusual color combinations requested by RCA designers. In addition, styrene offered excellent moldability of shallow cavities, beveled areas, and the symmetrical line face of the grill section.



**PRODUCTION.** Length of time required for getting a new model into production is always an important consideration. In this case, there was a minimum of delay between design and production. Cambridge Panelyte drew up final plans within 2 weeks, made the production mold inside of 3 weeks. Monsanto Lustrex styrene was selected for its flow characteristics that permitted high production cycles to be set and maintained on 32 oz. and 12 oz. injection molding machines. High impact Lustrex also provides the resilient toughness required for the grill and body.

**THE FINISHED PRODUCT.** The new RCA phonographs now on the market are enjoying a solid sales success. One of the factors in their universal acceptance is their strikingly handsome and lustrous cabinets of "pearl gray" and "flame red," molded in fine detail of Monsanto Lustrex styrene plastic.

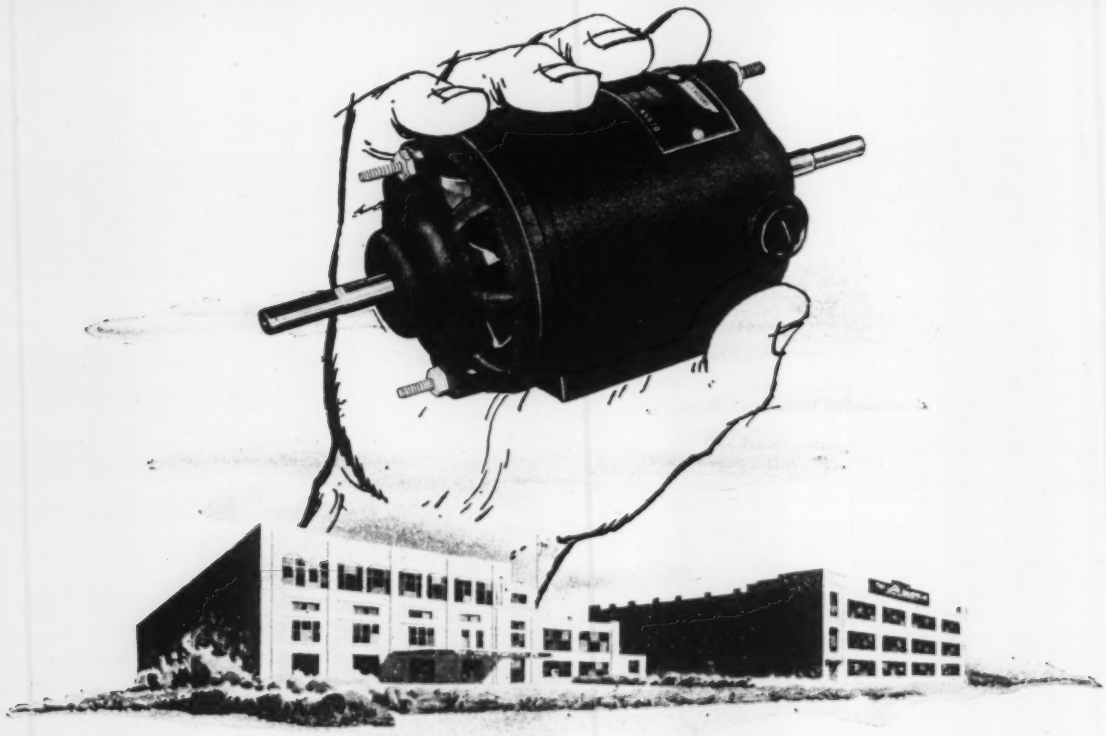
This is one of hundreds of design and production problems solved through the facilities and craftsmanship of the plastics custom molding industry. Monsanto will be glad to direct you to qualified molders who can help you in your new product design or improvement. Write to Monsanto Chemical Company, Industrial Applications Dept., Springfield 2, Mass.

Investigate Monsanto's completely balanced line of styrene formulations developed for particular applications and sold under the trade name...

LUSTREX Styrene Plastic

MONSANTO

Circle 535 on page 19



# CUSTOM-BUILT USE-ABILITY...

## for your motor-driven products

Exceptional performance and dependability go with useability in Lamb Electric Motors because they are:

**(1) "tailored" to the exact requirements of an application.**

**(2) built of quality materials by precision-minded personnel.**

Our company is equipped and organized to *custom-manufacture on a volume basis;* hence high quality and controlled costs go hand-in-hand.

We would like to discuss these advantages with you for *your* new and redesigned products.

**THE LAMB ELECTRIC COMPANY • KENT, OHIO**

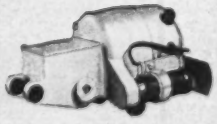
In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

*Lamb Electric*

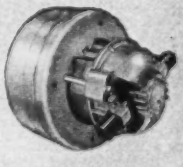
SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

Swivel-mounted portable tool motor.

Aircraft de-icing pump motor.



Gear motor for slow-speed drive.



Turbine for canister-type vacuum cleaner.

If you are interested in any of the motors at left write and we shall be glad to send full information.



Circle 536 on page 19

Circle 537 on page 19→

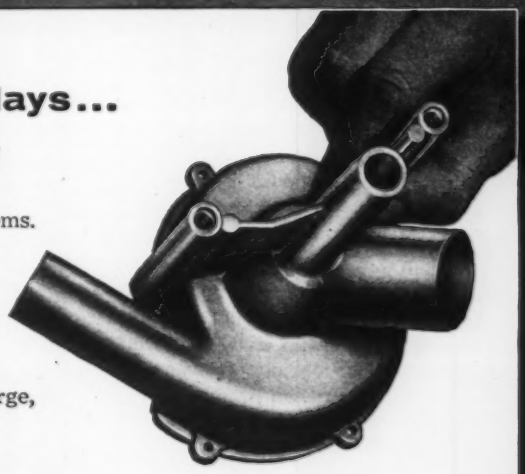
# 45 years OF SERVICE TO INDUSTRY

## We beat the schedule by days...

*but it took years of "training" to do it!*

This die casting presented some mighty tough problems. But nearly a half a century of experience gave Stewart engineers the special "know-how" needed to produce the job – and on schedule!

Why not put that experience to work for *you*? Whatever type of die casting you need – small or large, simple or intricate – you can count on Stewart to meet your most rigid specifications . . . on time.



This emblem is your assurance that the zinc alloy used in every Stewart die casting meets the rigid specifications established by the American Die Casting Institute.

# Stewart DIE CASTING

A DIVISION OF
STEWART-WARNER CORPORATION

Chicago, Illinois: 4535 Fullerton Avenue
Bridgeport, Connecticut: 275 Warren Street

STEWART SW WARNER

# JENKINS Fig. 106-A

**The FIRST**
**Renewable Composition Disc**
**BRONZE GLOBE VALVE**
**150 lbs. Steam 300 lbs. O.W.G.**
**⅛ in. to 3 in.**

## Making a Work Horse a Champion

Take a Fig. 106-A apart. It's easy to see the reason why it's the "champion" of disc-equipped Bronze Globes. Every part, from heatproof handwheel to pipe ends, reflects the design and construction skill of generations of Jenkins Valve specialists.

Jenkins Bros. introduced the first renewable composition disc Globe . . . is still the only manufacturer of both valves *and* discs.

Fig. 106-A not only looks better — it proves out better in performance. In any comparison, its long-life, low-upkeep record has always set the standard. That is the true measure of valve cost — and it is the reason why industry's shrewdest buyers will settle for nothing less than Fig. 106-A quality.

The Fig. 106-A "family", with interchangeable parts, provides Globe, Angle, and Check patterns to meet 90% of average valve needs.

Ask your Jenkins Distributor for full information, or write: Jenkins Bros., 100 Park Ave., New York 17.

**JENKINS**
LOOK FOR THE JENKINS DIAMOND
**VALVES**
SINCE 1864 TRADE JENKINS MARK
Jenkins Bros

**SOLD THROUGH PLUMBING-HEATING AND INDUSTRIAL DISTRIBUTORS**



Circle 538 on page 19

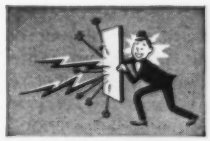
# A good combination...for an argument

## *Laminated plastics*...a combination of properties that *speaks for itself!*

Many industrial applications require materials that can deliver more than one property and can perform more than one function. Such a material is Synthane laminated plastic. This widely used basic material satisfies such diverse property requirements as good tensile, compressive and flexural strengths, low moisture absorption, low dielectric constant and low power factor, light weight and easy machinability. Various grades of Synthane are available to the designer in order to provide him with **just the right combination of properties** according to the mechanical, electrical and chemical requirements of his application.

This insulation plate made of Synthane has to take the toughest kinds of outdoor punishment. Used in heavy-duty generators for bulldozers and tractors, it must battle all kinds of weather, road dust, oils, greases, and vibrations. In addition to meeting these tough service conditions, Synthane also possesses the necessary light weight, mechanical and dielectric strengths, good machining properties, and the ability to be post-formed to the desired shape.

**A wide choice of combined properties!** Synthane offers over 30 individual grades in sheets, rods, tubes, moldings, and completely fabricated parts. Send for free illustrated catalog today.



DIELECTRIC STRENGTH

LIGHT WEIGHT

WEAR RESISTANCE

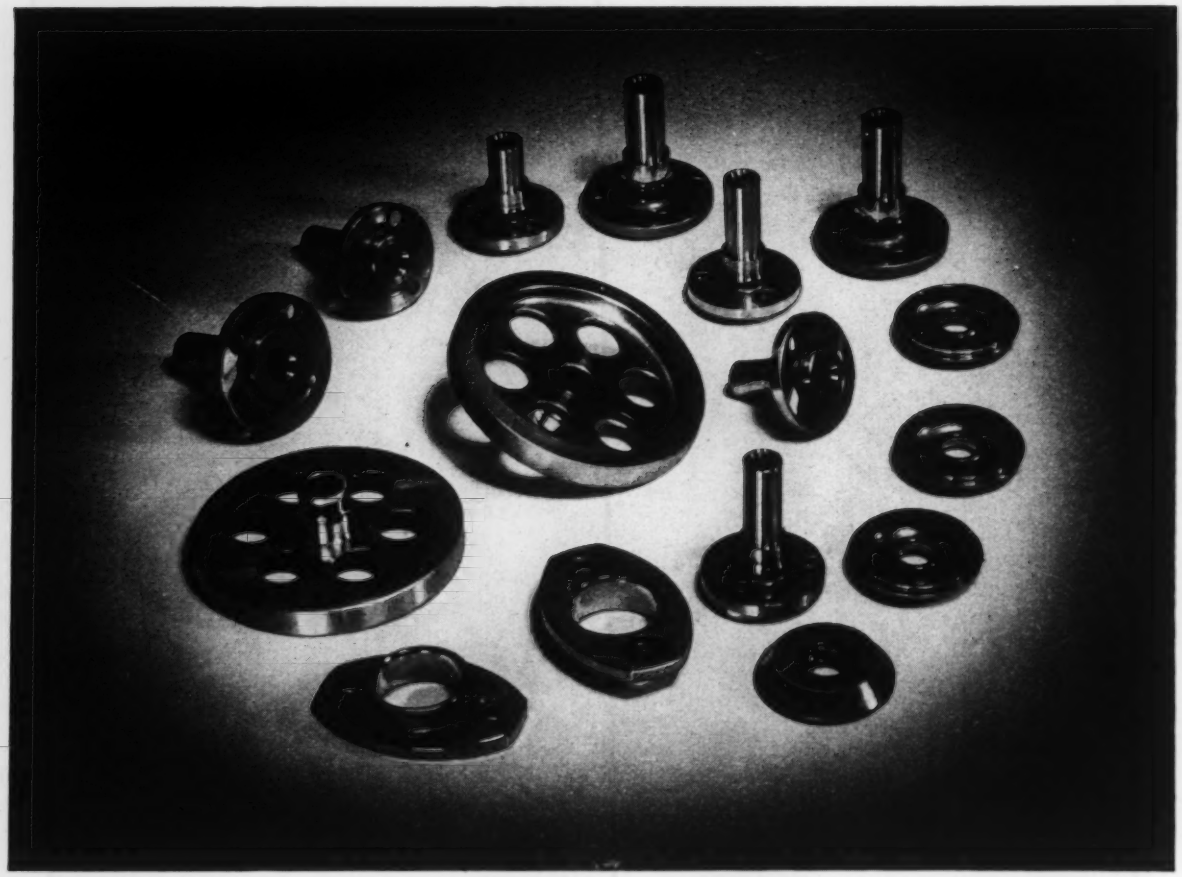
EASILY MACHINED

SYNTHANE

SYNTHANE CORPORATION, 5 RIVER ROAD, OAKS, PA.



Circle 539 on page 19



# bearing manufacturer gains over 300% higher yield with Vacuum Metals FERROVAC

Because a leading manufacturer of precision instrument bearings worked to such exacting standards, he experienced an exceptionally high rate of rejection of finished parts. Then they tried Vacuum Metals FERROVAC®. . . of the same basic analysis as the air-melted grade used previously. The results were decisive. Rejections were reduced to less than 1% – a yield improvement of better than three times.

That's to be expected from vacuum-melted alloys, because of their remarkable uniformity. Gases that cause inclusions and that in turn lead to rejection – or early bearing failure – are literally sucked from vacuum-melted alloys during production . . . before the metal becomes solid.

The result is a *clean* alloy – with many of its properties improved. It is stronger, tougher, far more resistant to wear and fatigue. It works longer and harder than conventionally-melted alloy – even does the super-tough jobs where *nothing else* will work.

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Circle 540 on page 19

(Advertisement)

# Design data on adhesives

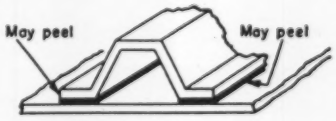
Armstrong
ADHESIVES • COATINGS • SEALERS

NUMBER FIVE

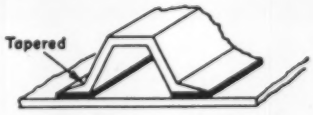
### How to minimize peel by changing stiffness

When stiffening members are attached to thin sheets, the sheets may deflect in service and set up peel stresses on the adhesive. Such peel stresses exerted on rigid adhesives can cause failure. Some structural adhesives, however, resist peel more than others. Proper design, too, can help.

For example, if the flanges on the stiffening section can deflect with the sheet, the peel problem will be minimized. Thus, reducing the stiffness of the flange on the stiffening section should result in improvement . . . as will increasing the stiffness of the base sheet itself. How stiffness may be changed to minimize peel is shown below.

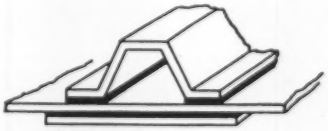



Basic assembly




Reduce flange stiffness with taper

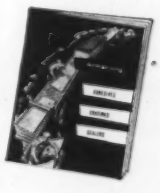
Reduce flange stiffness with grooves



Increase base sheet stiffness with extra member

**For more information**

Write for a copy of "Armstrong Adhesives, Coatings, and Sealers." Armstrong Cork Company, 8010 Dean St., Lancaster, Penna.



## BONDING METHODS:
## Wet assembly and contact bonding

Basically, assembly with adhesives involves placing cleaned and coated parts together, with the surfaces to be bonded held in intimate contact until the adhesive sets. There are various techniques for doing this, depending on the materials, their shapes, and the properties of the adhesive.

### Wet Assembly

This technique involves bringing the bonding surfaces together while the adhesive is liquid and holding them in this position with pressure until the adhesive sets or develops its bonding strength.

**BONDING VINYL TO METAL.** Here, adhesive is being sprayed on the vinyl covering and end posts of a folding door. This kind of application, where clamping is impracticable, requires an adhesive with high immediate strength.

With porous materials such as wood or paper, adhesives used can set chemically, or through the loss of volatile material, or merely through cooling as with hot melts. With nonporous materials, such as metal and plastics, loss of volatile material is practically impossible except at edges. With these materials, the adhesives used must be of the kind that set through chemical action, through cooling, or through polymerization or condensation at high temperatures. Or the bonds may be made when practically all the solvent is out as with "contact" adhesives.

In wet assembly, relatively low pressure is required while curing, and it is easy to obtain accurate alignment if mistakes in position are noticed before the adhesive sets. In addition, no floor space is needed for drying of adhesive-coated parts being prepared for assembly. On the other hand, pressure jigs may be necessary during curing, and on large operations, the amount of floor space involved can be substantial.

### Contact Bonding

This method requires only the application of pressure to adhesive-coated surfaces to accomplish the bonding. With contact adhesives, coating of only one surface is usually required.

Contact adhesives, with inherently higher strength than softer, truly pressure-sensitive products, generally work best when both surfaces are coated. However, if the adhesive is applied to only one surface, more solvent must be present in the film at the time of assembly to permit transfer of the adhesive. With Buna-N, neoprene, and reclaim-rubber adhesives, there is generally enough residual "tack" in the films after solvent evaporation, but tack range varies with each adhesive.

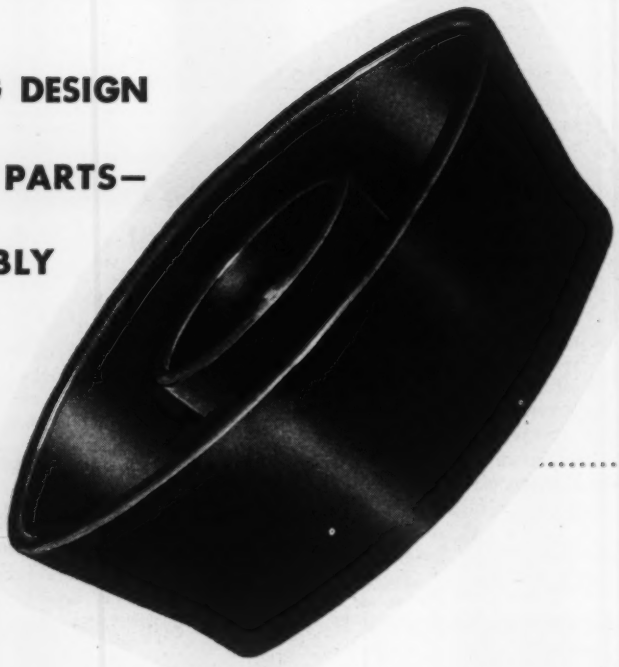
In joining nonporous surfaces, both surfaces should be coated, and the maximum amount of solvent should escape before assembly. Where one of the surfaces is permeable, however, the adhesive films need not be so dry. In bonding impervious materials with adhesives that lack adequate tack range for easy assembly, an inter-liner of cotton duck or chipboard will help the volatile material to escape. Then, the adhesive can be used in a softer condition than permissible where no volatile escape is possible.

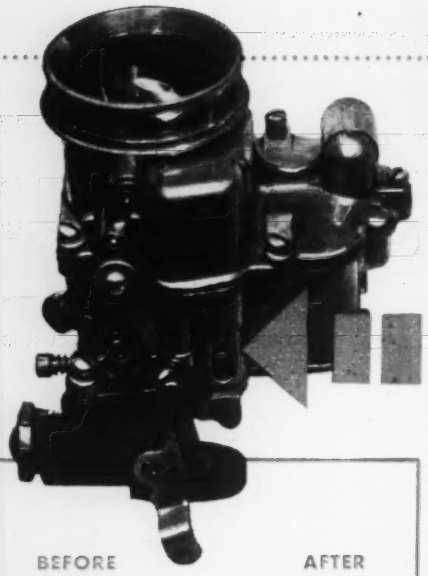
Generally, contact adhesives develop a reasonable bonding strength as soon as assembly is completed. Pressure requirements are usually low —often a hand roller will do the job —and pressure need be applied only long enough to ensure full contact.



Circle 541 on page 19

# NEW HOUGHTON PACKING DESIGN ELIMINATES THREE EXTRA PARTS— SIMPLIFIES TRICKY ASSEMBLY





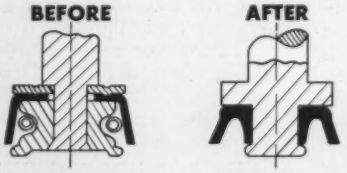
**In this automobile carburetor, one VIX-SYN "U" cup packing replaced an assembly of three separate parts—thanks to Houghton for coming up with this cost-cutting idea.**

By using a Houghton VIX-SYN synthetic Rubber "U" cup packing, Houghton experts built superior performance into a simpler unit. There's only one part to machine, and assembly is so simple anyone—even the most unskilled worker—can do it. The rubber "U" cup packing simply snaps on.

The result is a piston assembly that gives superior service, yet is far easier and cheaper to make than before. It's one example of the many ways Houghton packings reduce costs and solve design problems.

Be sure you are using the newest and best in packings and packing knowledge. Make a habit of talking to Houghton whenever you're working with packing applications. Just call your Houghton Man—or write E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Now—with one Houghton packing replacing three parts—there's only one machining job, no assembly problem. Nearly 17 cents saved per carburetor.




Once it took five separate parts plus a tricky peening job to produce this piston assembly. For something so small, it was complicated—and costly—to make.

**PACKINGS**

**. . . products of**

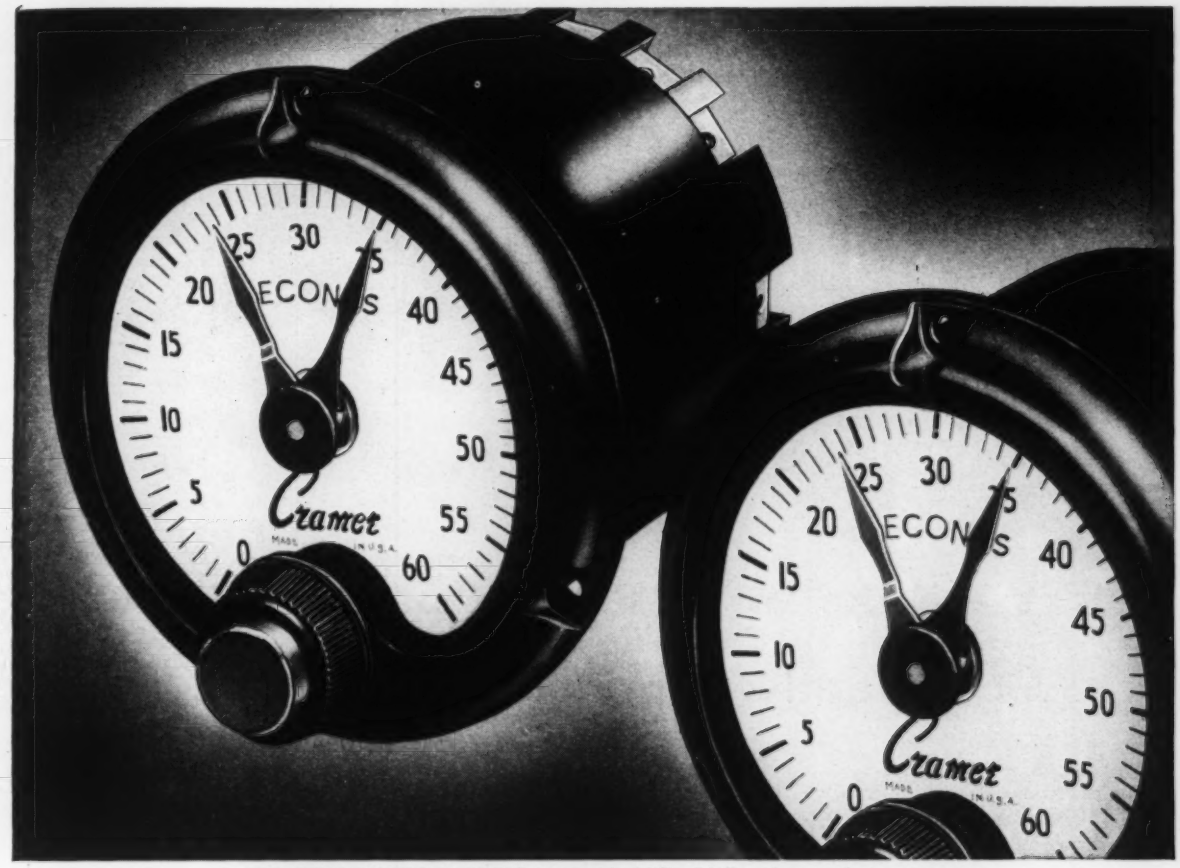
**E. F. HOUGHTON & CO.**

PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

***Ready to give you on-the-job service . . .***



Circle 542 on page 19




**NEW CRAMER INTERVAL TIMER** features ¼ of 1% of full-scale repeat accuracy, offers wide time-range selection.

# New automatic reset interval timer

**Eleven full-scale time ranges—15 seconds to 24 hours—give new Cramer Type 241 versatility and precision.**

Increased accuracy and operating convenience, a wide selection of time ranges, and lower costs to users are key features of the new Cramer Type 241 automatic reset interval timer.

The new Type 241 timer provides push-button starting and automatic shut-off after a predetermined time interval for a wide variety of electrically-operated equipment such as washing machines, mixers, ovens, tumbling and plating equipment, and laboratory and test equipment. Here's what it offers:

**Wide selection of time ranges** — 11 full-scale time ranges available ranging from 15 seconds to 24 hours.

**Heavy-duty contacts** — rated at 15 amperes, non-inductive load, provide capacity to handle high inrush currents.

**High overall accuracy** — within ± ½ of 1% of full scale, exclusive of human setting errors.

**High repeat accuracy** — within ± ¼ of 1% of full scale.

**Easy-to-read 3-inch dial** — a fully enclosed high-visibility, black-on-white dial features 300° scale, black setting pointer and red progress pointer for easy reading and accurate setting.

**Easy interval setting**—large setting knob, concentric with red start button, allows rapid setting to precise time intervals. And, important at longer time ranges, setting may be changed while unit is running.

You'll find complete data on the new Type 241 timer in Bulletin PB-211. Write for your copy today. The Cramer Controls Corporation, Box 6, Centerbrook, Conn. 6.4

**OUR NEW NAME**

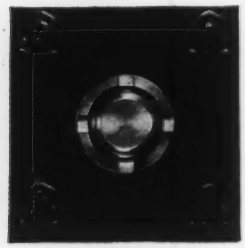
The R. W. Cramer Company has become The Cramer Controls Corporation. The reason? Simply that we outgrew the old name. We're still specialists in precision time control. And, you'll find us today ready and willing to serve you with better products and faster deliveries than ever before.

The Cramer Controls Corporation, Centerbrook, Conn.

CRAMER CONTROLS
CORPORATION



Circle 543 on page 19



# Here are the world's finest power cylinders

## ...competitively priced!

**This ad is written for the man** who has thought all cylinders are "pretty much alike." That just isn't so, and your Hannifin man would like an opportunity to show you why...

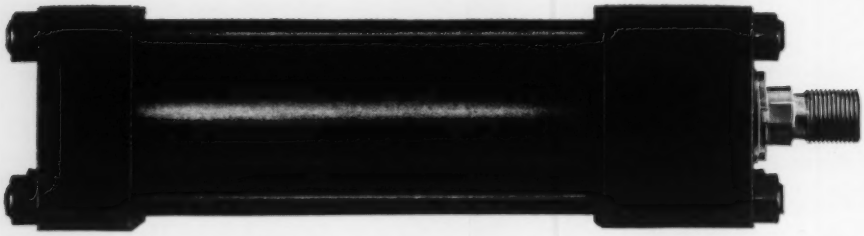
He'll show you design features that other cylinders simply do not have... extra quality workmanship at critical points that pays off in longer life ...accessibility that simplifies their infrequent maintenance. And when he talks price and delivery, you will find these better features cost you no more, can often be delivered sooner.

We think you'll agree that it pays to standardize on Hannifin cylinders.

AIR AND HYDRAULIC

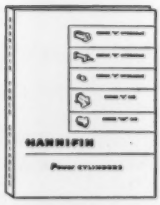
**HANNIFIN**

POWER CYLINDERS



**COMPLETE CYLINDER FILE**

Write for your copy of this new Hannifin Cylinder File . . . complete, easy-to-use, easy-to-order-from information on five lines of Hannifin Cylinders. Write Hannifin Corporation, 515 S. Wolf Road, Des Plaines, Ill.






Circle 544 on page 19

Circle 545 on page 19→

DU PONT
REG. U.S. PAT. OFF.
PRODUCT ENGINEERING NEWS
PROPERTY AND APPLICATION DATA
ON DU PONT "ZYTEL" NYLON RESIN

# Many design improvement opportunities possible with ZYTEL® nylon resin

PRODUCTS molded from ZYTEL nylon resin are light in weight, strong and tough even in thin sections. They are resilient, resist permanent deformation and absorb shock and vibration. ZYTEL retains its form stability at high temperatures and its impact strength and flexibility even below zero. Parts of ZYTEL offer high hardness, excellent abrasion resistance and low coefficient of friction—require little or no lubrication for long service and quiet operation.

In addition to these superior mechanical properties, ZYTEL is unaffected by oils, grease, electrolytic corrosion and most solvents or chemicals. ZYTEL fits into many electrical applications because of its heat resistance and insulating properties.

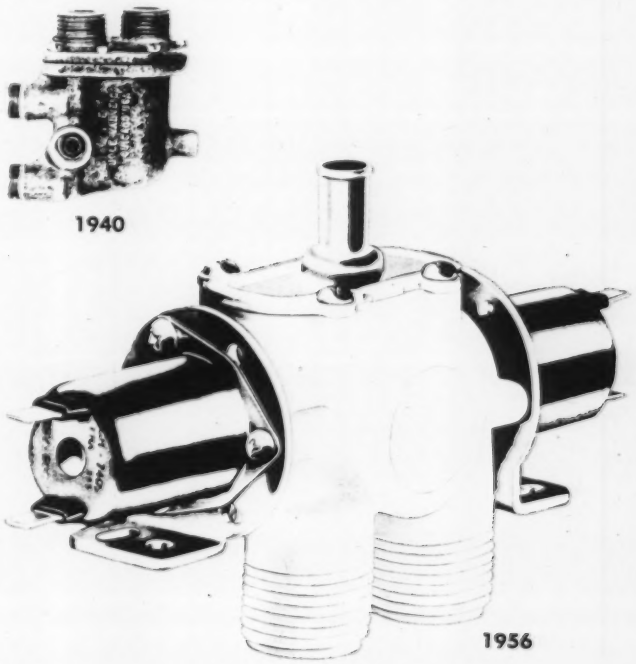
Du Pont ZYTEL is readily molded to close tolerances and easily machined on standard metal-working equipment. You'll find that articles of ZYTEL provide superior performance at substantial savings in cost.

Examples of improved product design shown on the following pages illustrate the unusual versatility of Du Pont ZYTEL for mechanical parts. Abrasion resistance, impact strength and low coefficient of friction of ZYTEL result in quieter operation and superior performance with reduced maintenance for bearings, gears and cams. Light in weight, strong in thin sections, and able to be accurately molded into complex shapes, ZYTEL often permits simplified one-piece design to replace an assembly of parts. Because ZYTEL is inert to oils and most chemicals—retains its properties at high or low temperatures—it finds many applications where ordinary materials would quickly fail.

Check the designs on the following pages. You may find that, by incorporating parts molded of ZYTEL nylon resin in your product, improved performance and reduced costs will result.

Complete property and application data on Du Pont ZYTEL are available to you. Mail the coupon on the last page of this insert.

OVER




The valve housing of this automatic home washer is an example of the design improvement possible with ZYTEL. The inlets of the solenoid-operated Dole Water Control Unit provide a leakproof connection with standard hose couplings. The resistance of ZYTEL to water and chemicals prohibits corrosion, reducing maintenance and replacement costs. (Valve molded by Chicago Molded Products Corporation of Chicago, for The Dole Valve Company, Chicago, Illinois.)

PRODUCT ENGINEERING NEWS

DU PONT

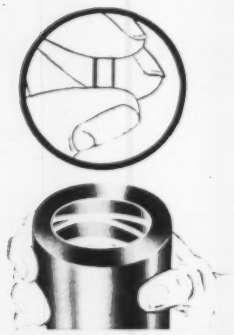
PROPERTY AND APPLICATION DATA ON DU PONT "ZYTEL" NYLON RESIN

Better Things for Better Living . . . . through Chemistry

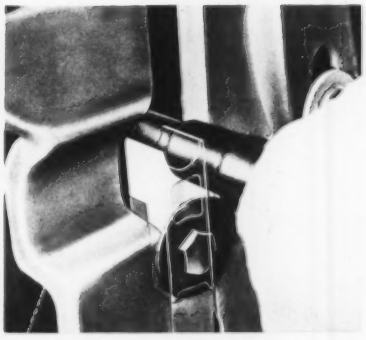
NO. 7, 1956

# 18 product

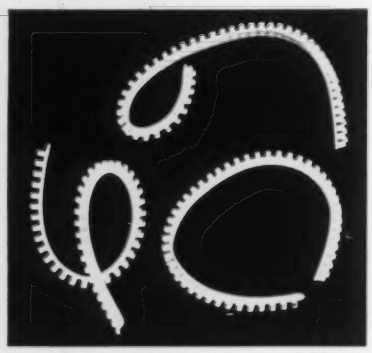
**These counter wheels** are molded in two different colors from ZYTEL. Light in weight, ZYTEL enables faster movement of the wheels with less power and a minimum of noise. (Manufactured by Electric Manufacturing Co., Inc., San Francisco, California.)



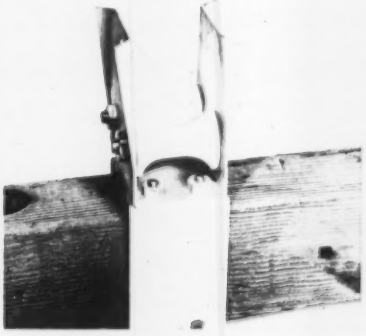
**Nylon-lined sleeve-type bearing** is composed of metal shell with molded lining of ZYTEL. Lining allows rapid heat dissipation and resists deformation, permitting high unit loading. (Produced by Nylacore Corporation, Glen Cove, New York.)



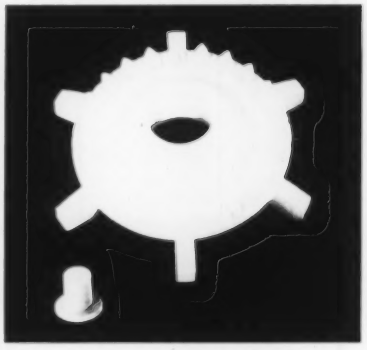
**This cloth-roll bearing** used in looms is made of ZYTEL, because it wears longer—requires little or no lubrication. ZYTEL replaced other materials which wore out from lack of lubrication. (Manufactured by the H. F. Livermore Corporation, Boston, Massachusetts.)



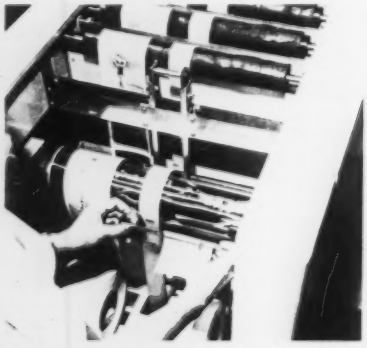
**Grommets of ZYTEL** are flexible and strong in thin sections—protect wire insulation from chafing in eyelets of any size or contour. These grommets are quickly cut and fitted from a 10-inch "Caterpillar" strip. (Manufactured by Nylon Molding Corporation, Garwood, N. J.)



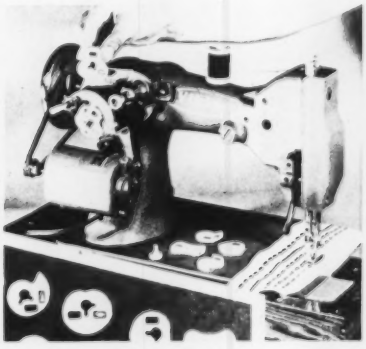
**Cable stringing block** is equipped with spools of ZYTEL which are abrasion-resistant and tough—will not damage cables. (Processed by Engineered Products, Inc., Kirkwood, Missouri for D. H. S. Company, St. Louis 17, Missouri.)



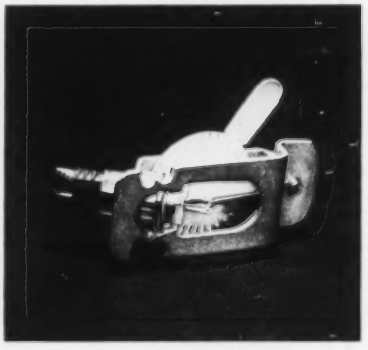
**Oil slinger gear** of wear-resistant ZYTEL operates quietly and withstands high temperatures inside an air-cooled engine. Stop switch button of ZYTEL stays cool even when engine is at 200° F. (Molded for Briggs and Stratton Corp., by Sinko Mfg. & Tool Co., Chicago.)



**The belting** of this photo processing machine is made of ZYTEL—is unaffected by developing and cleaning solutions. ZYTEL has high tensile strength, even in thin sections, and is resilient and flexible. (Belting produced by The Polymer Corporation of Pennsylvania, Reading, Pennsylvania.)

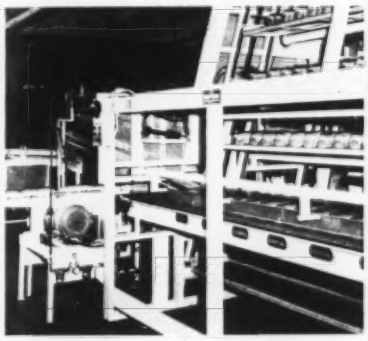


**Interchangeable cams** of ZYTEL in this sewing machine provide variations in stitching patterns. ZYTEL simplifies production, lowers costs due to ease of molding. (Molded by Boonton Molding Company, Boonton, New Jersey, for Consolidated Sewing Machine Corporation, New York, New York.)

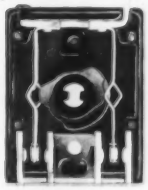


**Phonograph needle holder** of ZYTEL is molded into intricate shape and holds switching mechanism for different speed needles. Important in this application are the good dielectric properties and toughness of ZYTEL. (Phonograph needle holder manufactured by Electro-Voice, Buchanan, Michigan.)

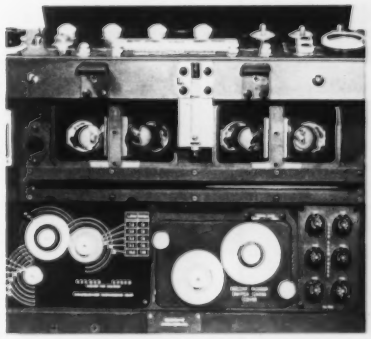
# examples of improved design with ZYTEL® nylon resin



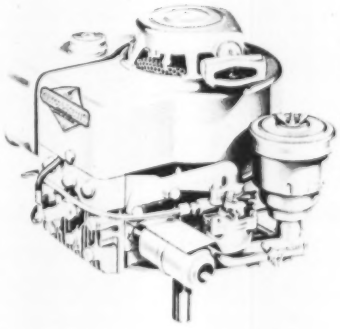
**The rollers** of this bread cooling equipment are manufactured under the Sanitation Code. Over-all performance of ZYTEL is found superior to that of metal. (Molded by United Plastics Industries Inc., Vassar, Michigan, for Baker Perkins Inc., Saginaw, Michigan.)



**The cams** which control the indexing of this rotary switch are made of ZYTEL. Because of its durability and strength qualities, ZYTEL replaced another material. (Molded for Cutler-Hammer Inc., by Sinko Mfg. & Tool Co., Chicago, Illinois.)



**This recording oscillograph** contains parts made of ZYTEL which give improved performance and provide accurate measurement in all phases of operation. (Manufactured by Consolidated Electrodynamics Corporation, Pasadena, California.)

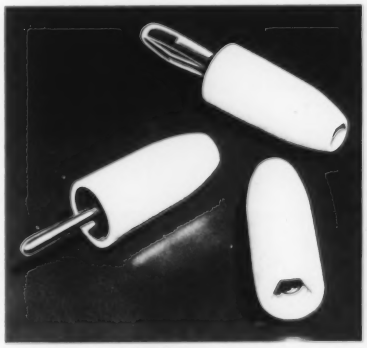


**The bumpers** for the starter pulley of this engine are made of ZYTEL, are adaptable to mass production. Quiet operation and longer wear result, because ZYTEL requires little or no lubrication. (Engine produced by Briggs and Stratton Corporation, Milwaukee, Wis.)

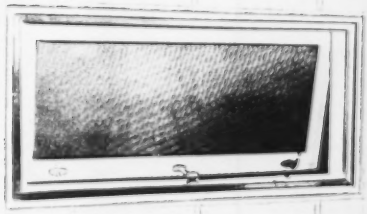
**Bushings** in a new sealed journal box Kit are made from ZYTEL. Important in this railroading advancement is the ability of ZYTEL to withstand extremes in temperature. (Manufactured by National Motor Bearing Company, Inc., Redwood City, California.)

**The gears, bearings and blades** of this mixer are made of ZYTEL because it is light in weight and resistant to heat, wear and corrosion. The Maynard Manufacturing Company of Glendale, California, expects these parts made of ZYTEL to outlast useful mixer life.

**This pneumatic sump pump,** run by air pressure, contains four vanes of ZYTEL. Driven at high speeds, the vanes are resistant to wear and are molded to extremely close tolerances. (Molded by Ingwersen Manufacturing Co., Inc., Denver, Colorado, for Gardner-Denver Company, Denver, Colorado.)



**Tip jacks of ZYTEL** have high dielectric strength, resist heat, cold and moisture, and stand up to high voltages under rugged operating conditions. Threaded insulating sleeve of ZYTEL with standard tip jack provides superior connector. (Manufactured by E. F. Johnson Company, Waseca, Minnesota.)



**The latch** on this window assures long-time service, because of the toughness, abrasion-resistance and high-impact strength of ZYTEL. (Molded by DuBois Plastic Products, Inc., Buffalo, N.Y., for Curtis Companies, Inc., Clinton, Iowa.)

OVER

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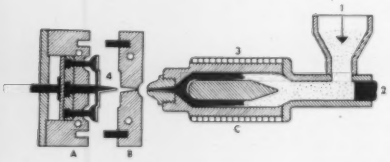
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA
ON DU PONT "ZYTEL" NYLON RESIN

## Injection molding process is rapid production method

INJECTION molding is one process for producing large quantities of plastic parts. A typical injection-molding assembly, shown in the diagram, operates as follows:




Parts marked *A* and *B* close and lock to form the *mold;* they move to contact part *C*, which contains molten plastic. Measured quantities of the granulated plastic (*1*) are fed into the machine. The reciprocating *ram* (*2*) forces this material into the *heating chamber* (*3*), where the powder liquefies. Each forward motion of the ram (*2*) forces molten plastic into the closed mold (*A* plus *B*), where the plastic solidifies and forms the *molded part* (*4*). Then the mold opens as shown in the diagram and the plastic part is ejected. In the meantime, the ram moves back, allowing more powder to feed into the machine, preparing it for another molding cycle.

The production rate depends on a number of variables, including the size of the part and the number of identical cavities cut into the mold. If molded parts are small, dozens of them can be made at one shot, whereas large parts may be produced one at a time. Cycles of 1 or 2 moldings a minute are not uncommon.

Here are some of the advantages of injection molding:

1. High rate of production
2. Economical production in quantity
3. Little or no finishing cost
4. Parts molded to close tolerances.

## Economical and durable control switch made with ZYTEL® nylon resin

The durability and impact resistance of ZYTEL permit reduced costs in the Saxony switch, because less wall thickness is required. The multiple switch controls the temperature of electric heating pads and is molded by Wilmington Plastics, Wilmington, Del., for Saxony Electronics of Wilmington.

FUNCTION and appearance, coupled with cost, are important factors in the design of a new product. Because of this, the Saxony multiple switch, which controls the temperature of electric heating pads, is molded of ZYTEL.

ZYTEL was chosen for the Saxony switch because of its durability and impact strength, even in thin sections. The thinner walls of ZYTEL result in economy of material, and a reduction in costs.

Its low coefficient of friction gives ZYTEL excellent bearing characteristics. For this reason, the moving parts of the switch are also molded of ZYTEL nylon resin.

Available in white and in a wide range of colors, ZYTEL nylon resin permits a variety of design possibilities. Readily molded to close tolerances, ZYTEL is an excellent material for applications such as the Saxony switch.

For complete information on this versatile material—property tables, typical applications, and production techniques—simply clip and mail this coupon.

**E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT**
**Room 3033, Du Pont Building, Wilmington 98, Delaware.**
***In Canada: Du Pont Company of Canada, Ltd., P. O. Box 660, Montreal, Quebec.***

***Please send me more information on Du Pont ZYTEL nylon resin. I am interested in evaluating this material for:***

_____

NAME_____ POSITION_____

COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

## NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of this versatile Du Pont engineering material.

# GREGORIO JARQUE and SON demonstrate the little sheave with the big grip

**Easy on** Bruce Jarque uses a standard wrench to assemble.

**Easy off** Two pull-up screws are used to break the cone grip.

**Yet always tight on the shaft**
Gregorio Jarque is no match for the QD Junior.

## Exclusive tapered, split hub on Worthington QD Junior sheave grips the shaft so tightly it can't be dislodged

This two-piece, light-weight sheave has a heavyweight's grip. An exclusive tapered, split hub grips the shaft so tightly wrestler Gregorio Jarque can't dislodge it. Tests show the Worthington QD Junior will remain tight even under a torque force of 3300 pounds.

It's built for staying power—won't loosen or slip under shock or pulsating loads. Yet it's always easy to remove from the shaft.

**Some other money-saving features of the QD Junior:**

**One Common Hub** is standard for 54 stock sheave sizes, ranging from 3.2 to 18.4 inches pitch diameter.

**Tapped Holes** allow use of pull-up bolts as jack screws to break cone grip when removing rim from hub.

**Heavy Hex Head Bolts** fasten rim to hub. No special tools are required to remove or install the QD Junior. A standard hex socket wrench is all that's needed.

**I-beam Arm** (in larger sizes) gives more strength with less weight.

You'll find it's easy to select the proper light-weight sheave and FHP V-belt drive from bulletin FHP-100-B1A. Write for your copy today. Worthington Corporation, Section MV65, Oil City, Pa.

MV.6.5

**WORTHINGTON**

Circle 546 on page 19

# MICRO precision switches

...THEIR USE IS A PRINCIPLE OF GOOD DESIGN

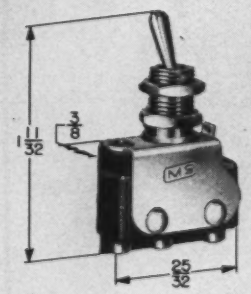
make

## MICRO SWITCH engineering service your short cut to NEW DESIGN IDEAS

MICRO SWITCH Engineering Service is devoted to assisting industrial designers in the solution of complex switching problems.

This service—as close as your telephone—places at your disposal a knowledge of switch applications obtained through years of research and field experience. We are experts on just one thing—precision switching problems.

We may have already solved a problem similar to yours—for somebody else. Should your problem turn out to be entirely new, MICRO SWITCH can—and will—develop the switch you need.




### RELIABLE TOGGLE SWITCH where inches and ounces count

Two of these MICRO SWITCH Type "AT" subminiature toggle switches serve as components for a small, lightweight portable geiger counter.

The extreme reliability and long life of the extremely small MICRO SWITCH units were important factors in their choice by the design engineers. This switch weighs but .02 lb. It has single-pole, double-throw contact arrangement. Rating of basic switch is 5 amperes 125 or 250 volts a.c.

*(Send for Catalog 73B—"Toggle Switches" and 75A—"Subminiature Switches")*

### LIMIT SWITCHES operate 57,000 times a day—day-in, day-out

MICRO SWITCH "ML" Type limit switches—17 of them—are used in an automatic grinding machine to control the steps in grinding small parts. Features which governed their selection by the design engineers were:

1 **Long Life:** some switches operate every 1½ seconds, three shifts a day—over 57,000 operations a day.

2 **Precision:** switches repeat exact operating point through millions of precise operations.

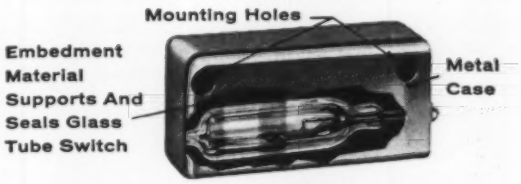
3 **Protection:** switches are well housed and protected against effects of oil splash, dirt and dust.

4 **Versatility:** three different types of actuating heads are used. Switches are adjustable to meet varied types of actuation and for mounting in cramped quarters.

*(Send for Catalog 83—"Industrial Enclosed Switches")*

# ...have uses unlimited

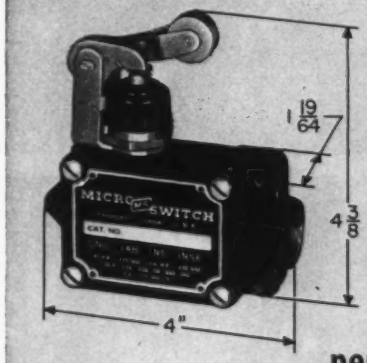
## MERCURY SWITCH accurate to ⅛ inch in 12 feet on grader




*(Send for Catalog 90-A—*
*"HONEYWELL Mercury Switches")*

Mercury switches are not usually associated with such applications as heavy road grading machinery. However, four of these protected HONEYWELL Mercury Switches have proved successful as grader blade controls.

Tilt action of the switches actuates a series of power relays and valves to control the grader blade. The switches are so sensitive that they are able to control the level of the blade within ⅛ of an inch in an overall movement of 12 feet. The switches—embedded in epoxy within a metal case—are extremely resistant to shock and exposure to the elements.




## MAXIMUM ACCURACY plus long-life performance

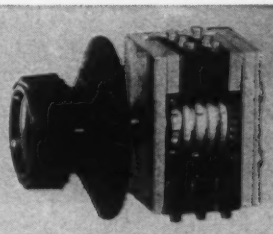
Switches used in woodworking production equipment—cut-off saws, rip saws, gang saws and jointers—must take a lot of punishment and retain maximum accuracy for a long life.

These enclosed switches, with roller arm actuator and sealed plunger, were chosen by designers as controls on an automatic air-operated cut-off saw. One switch controls the reversing of the solenoid for length of stroke. The other is a return control.

Both switches must operate with maximum accuracy and give long-life performance. At an average of 1,250 strokes per hour, the switches are activated 10,000 times in the average 8-hour work day.

*(Send for Catalog 83A—*
*"Industrial Enclosed Switches")*

## FIVE tiny switches permit 32 on-off situations

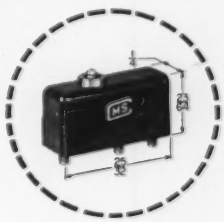


Five MICRO SWITCH subminiature switches were selected by design engineers in this rotary selector switch to provide the switching function for each of the pulse positions in a five-pulse binary code switch. Each switch is of single-pole, double-throw design, thus providing 32 on-off current combinations for data processing equipment.

The binary switch is a single control, positive locking, electro-mechanical device for converting rotary operation into a binary sequence.

According to the designers, the MICRO SWITCH subminiature switches were chosen because of:

1. Small size and light weight (¾ x ½ x ¼ inch)—(265 per pound).
2. Ease of operation.
3. Reliability.
4. Extremely low contact resistance (through use of fine silver).
5. Positive make and break action.
6. Resistance to shock and vibration.
7. Low capacitance between open contacts and from terminals to ground.



There is no limitation in the design as to the number of switches that can be used.

*(Send for Catalog 75A—"Subminiature Switches")*

**MICRO SWITCH**
A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
In Canada, Leaside, Toronto 17, Ontario • FREEPORT, ILLINOIS

# CONTROLLED PRESSURE AT 100,000 PSI!

**Superior super pressure quality tubing has been used to handle internal pressures from 15,000 to 100,000 psi—offers high fatigue strength, chemical resistance and burst pressure to spare**

In *any* industry, handling liquids and gases safely and efficiently under extremely high pressures can be done best by using only top-quality tubing. And Superior *specializes* in premium quality super-pressure tubing.

Superior produces this tubing from specially selected raw materials which have had the inside surfaces conditioned to remove fissures and other defects. In processing, special degreasing operations are performed on the tubing, and the inside diameters are sand blasted to insure a clear, smooth surface.

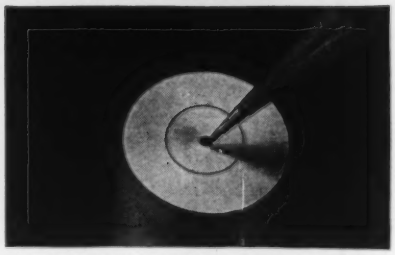
Two types of Superior super pressure tubing are available: a single wall mechanical tubing and a double wall, or composite unit, made from two thinner tubes.

Super pressure tubing is produced in an annealed condition and in ⅛ hard temper, and to mechanical properties specified by the customer.

This tubing is offered in the austenitic stainless steels, Types 304, 316, 321 and 347 and in AISI 4130 alloy steel. It is produced in sizes ⅛" OD x 1/16" ID up to ¾" OD x 1/16" ID. Minimum order quantity for mill production is 50 ft. per size and analysis.

Superior rigidly inspects all super pressure tubing for defects such as fissures by visual and microscopic inspection methods. Each length is hydrostatically tested to 5000 psi—upon request, up to 60,000 psi.

If you have a tubing problem in high pressure processing—or of any other nature—call on Superior. Write Superior Tube Company, 2010 Germantown Ave., Norristown, Pa., for Data Memorandum 22.



The composite type stainless super pressure tubing offers the advantage of having the inner and outer tubes independently worked to mechanical property requirements and of different alloys being combined for strength and corrosion resistance.

SUPER PRESSURE TUBING MINIMUM BURSTING PRESSURES FOR AUSTENITIC STAINLESS STEELS AND 4130 ALLOY STEELS

| | MAXIMUM WALL | | | |
|---|---|---|---|---|
| OD | .053 | .095 | .156 | .218 |
| ⅛ | *97,200<br>84,400 | | | |
| ¼ | *40,200<br>34,800 | 82,000<br>71,000 | | |
| ½ | *17,400<br>15,000 | 33,500<br>29,100 | 62,500<br>54,000 | |
| ⅝ | *13,600<br>11,800 | 25,000<br>21,600 | 47,600<br>40,300 | 72,600<br>63,000 |

*Top figures all Austenitic Stainless Steels
Bottom figures all 4130 Alloy Steels

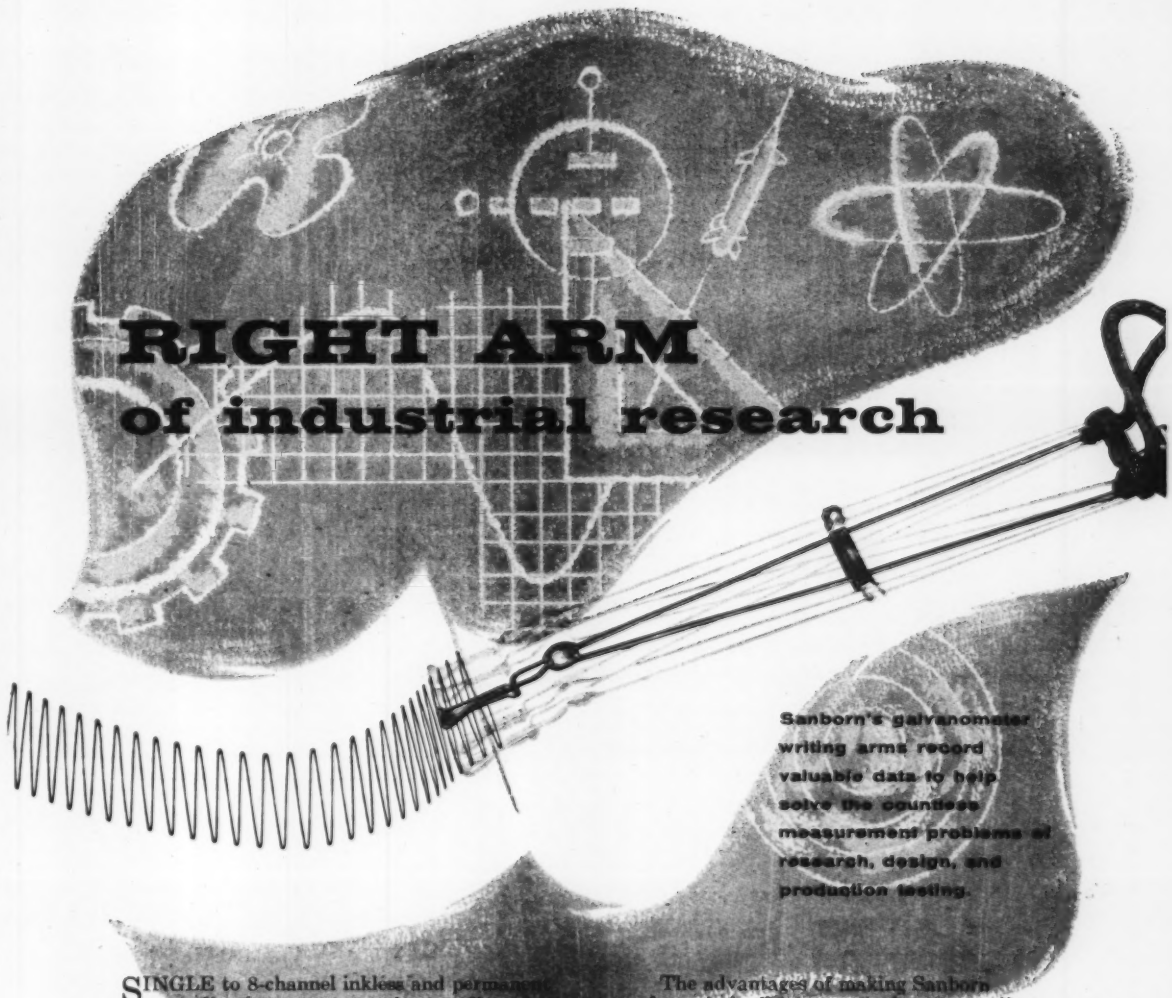
# Superior Tube

**The big name in small tubing**

**NORRISTOWN, PA.**

*All analyses .010" to ⅝" OD—certain analyses in light walls up to 2½" OD*

West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331



# RIGHT ARM of industrial research

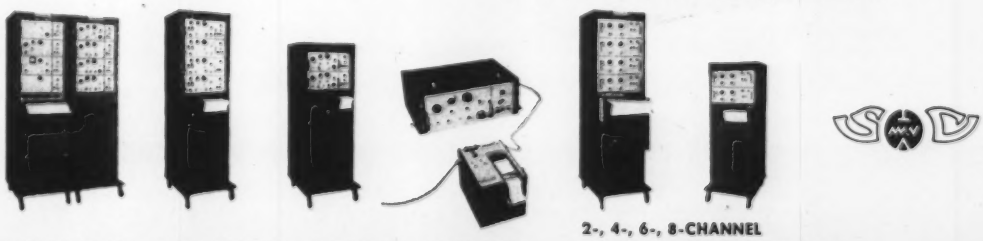
Sanborn's galvanometer writing arms record valuable data to help solve the countless measurement problems of research, design, and production testing.

SINGLE to 8-channel inkless and permanent recording in true rectangular coordinates of 0-100 cps phenomena — ranging from telemetered aircraft data to atomic reactor characteristics — is the vital and growing role of Sanborn oscillographic recording systems in industry. The Sanborn file of users indicates that such recordings are aiding in the dynamic analysis of jet engine starters, machine tools, agricultural machinery and oil drilling equipment; performance of pilotless target aircraft, modern submarines and tracking radar systems; and the production testing of servo components, valve positioners and precision potentiometers. Sanborn systems designed especially for recording analog computer output extend applications further — in simulated flight set-ups, solution of complex problems with six or eight variables, etc.

The advantages of making Sanborn equipment the "right arm" of *your* recording problems include extreme *flexibility*, by means of a dozen different interchangeable, plug-in "150 Series" preamplifiers which quickly and economically adapt a basic system to changing requirements; choice of 1-, 2-, 4-, 6- or 8-channel systems, in vertical mobile cabinets or "portably packaged"; numerous chart speeds, many individual channel controls, and high over-all system linearity.

To see how oscillographic recording the Sanborn way can become the "Right Arm" of *your* analysis work, write for detailed information or contact your Sanborn Representative. Sixteen-page "150 System" catalog on request.

**SANBORN COMPANY**
*Industrial Division, Cambridge 39, Mass.*



8-, 6- CHANNEL | 4-CHANNEL | 2-CHANNEL | 1-CHANNEL | 2-, 4-, 6-, 8-CHANNEL ANALOG COMPUTER SYSTEMS



Circle 549 on page 19

# need quick service on TIMERS for automatic control?

Time Delay Timers

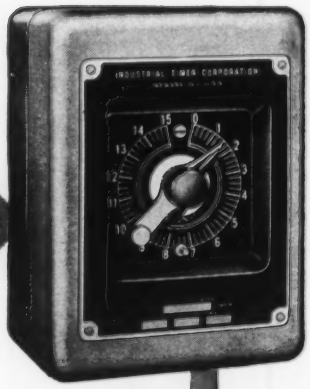
The more automatic control problems we get, the better we like it. For while it's true each automatic control job is a bit different from the rest, the record shows that our 19 years of timer experience has given us the special knowledge it takes to give you the right answers, and in near-record time.

If one of our standard timers won't do your job — or one of the 721 combinations we have thus far developed from our 17 basic units — our engineers will go right to work to develop a new combination that's the one for you. That's the way we grow — and we like it.

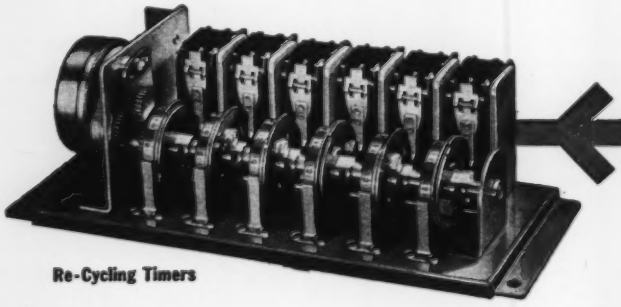
We manufacture a complete line of timers in these 4 broad classifications:

**TIME DELAY TIMERS • INTERVAL TIMERS**
**RE-CYCLING TIMERS • RUNNING TIME METERS**

And since we maintain large stocks of our 17 basic units, we can assure you of rapid deliveries — of excellent deliveries even on special orders. So whatever your automatic control problem, you have everything to gain by submitting it to our timer specialists. They'll give you a profitable answer — almost with the speed of automatic control itself.



Interval Timers



Re-Cycling Timers

Running Time Meters

*Timers that Control the Pulse Beat of Industry*

INDUSTRIAL TIMER CORPORATION

**INDUSTRIAL TIMER CORPORATION**
1413 McCARTER HIGHWAY, NEWARK 4, N. J.



Circle 550 on page 19

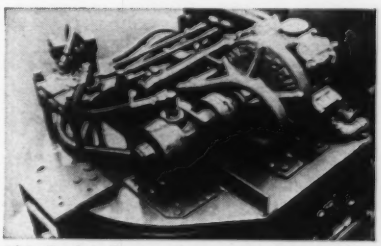
**Gardner-Denver . . .** Serving the World's Basic Industries

Barrett-Craven's Air Palletier stacks pallet loads in ship's hold.

## Gardner-Denver Air Motors Eliminate Explosion Hazard

When explosion hazard runs high, as with stowage of refinery products aboard ship, specifications call for air-operated, explosion-proof lift truck in pallet handling. Engineers designed a Gardner-Denver air motor into this Air Palletier to eliminate all electrical devices: motors, contactors or resistors—the principal causes of sparking.

This is another example of Gardner-Denver air motors serving the requirements of industry. Although your problem may not concern fire or explosion, you can put these air power features to work—profitably. Gardner-Denver air motors can't spark . . . won't heat up under constant starting, stopping, reversing . . . won't burn out when overloaded. Send for descriptive bulletins.



This Gardner-Denver air motor is connected to a pump which develops hydraulic pressure to elevate the Air Palletier lifting forks. A second air motor supplies driving power. The air hose leading from truck supplies air from a compressor or air line.

**GARDNER - DENVER**

THE QUALITY LEADER IN COMPRESSORS, PUMPS, ROCK DRILLS AND AIR TOOLS FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario



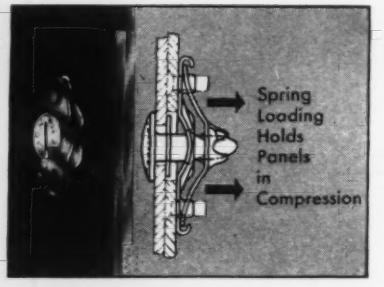
Circle 551 on page 19

# Quick-Opening Fasteners

## *Selecting Small Fastenings for Metal Closures*

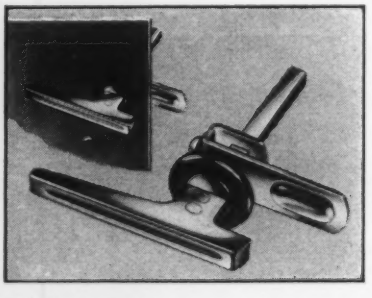
*"Use captive fasteners wherever feasible  Avoid the use of loose washers and loose nuts  Fasteners on equipment covers should be operable either with no tools or with standard hand tools"**

*(John D Folley, Jr & James W Altman, Research Scientists, American Institute for Research)*




### Quarter-Turn Fastener

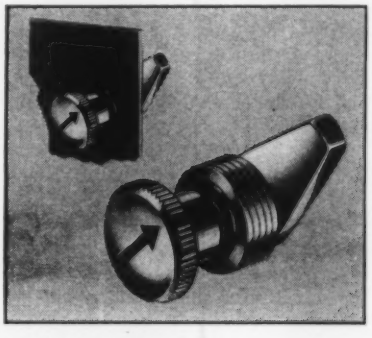
Lion Fasteners open and close with a ¼ turn, hold sheets tightly under the compression of a rugged spring Quickly operated and fully retained in the outer panel, they are approved under U. S. Government military specifications. Stud and receptacle float for easy alignment and simplified hole preparation. Flush, oval, wing, knurled, ring, and key head styles available Sizes—No. 2, No. 5, and High Strength for extra heavy duty



### Cabinet Latch

Just drill a hole, push the fastener stem through, and slide the special push-on clip into place No welds, screws, bolts or rivets: the fastener is permanently installed in seconds!

Adjustable to any grip length or panel thickness, the pawl is fixed in place by a single set screw. The fastener's brightly finished knob is set off by a plated washer. Also furnished with screwdriver operated flush head.

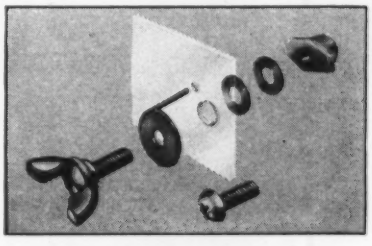


### Spring Tension Latch

For fastening slide-out drawers and hinged panels the Southco Arrowhead Latch is recommended It locks or opens with a quarter turn yet occupies less than ½″ inside space

Doors are held under spring tension—a push against the arrowhead knob relaxes this tension, allows operation with fingertip ease Drill a single hole for installation—no fastening to the door is necessary. No striker plate is needed

Pawl stop is eliminated—arrowhead shows at a glance exact position of pawl



### Adjustable Panel Latch

Small doors and panels can be fastened with greatest speed and lowest cost with the Southco Adjustable Latch.

The entire fastener is quickly installed through two holes punched in the door, no bolts or rivets are needed.

It operates with a quarter turn, requires no striker plate. An extra twist after the nylon pawl is engaged pulls up the door to form a seal and eliminate vibration.

Available with wing, knurled, or Phillips head

### Free Fastener Handbook

Send for your free copy of Fastener Handbook No. 7, just released. Gives complete engineering data on these and many other special fasteners. Fifty-two pages, in two colors.

Write on your letterhead to Southco Division, South Chester Corporation, 237 Industrial Highway, Lester, Pa.

SOUTHCO FASTENERS

LION

©1956

* *Quotation from "Designing Electronic Equipment for Maintainability": Machine Design, July 12, 1956*

# J&L cold drawn ELECTRICWELD tubing now available with a superior SPECIAL SMOOTH I.D. finish

Reduces your over-all production costs in applications like these . . .

- **cylinder tubing**
- **hydraulic and pressure tubing**
- **shock absorbers**
- **ordnance components**

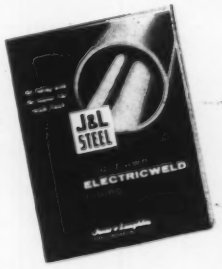
This new drawn-over-mandrel grade tubing with its mirror-like inside surface finish is today busy helping manufacturers reduce or entirely eliminate costly machining on many applications and is being substituted for more costly types of steel tubing. For example, it may be used, without inside honing, for many cylinders through which plungers are passed.

J & L Cold Drawn ELECTRICWELD Tubing with a *Special Smooth* ID finish combines the physical advantages imparted by today's modern electric welding techniques with those of cold working. It withstands high internal hydrostatic pressures, carries heavy torsion loads, resists high-frequency vibration, and offers a favorable weight-to-strength ratio for applications in which loading occurs in all directions.

J & L Cold Drawn ELECTRICWELD Tubing can be furnished in its three specifications in OD sizes from ½ inch to 2⅞ inches and in wall thickness from 20 to 10 gage, 0.035 and 0.134 inch respectively.

A new booklet provides the information you need . . . specifications . . . tolerances . . . chemistry . . . mechanical properties . . . annealing . . . finishes.

J&L STEEL



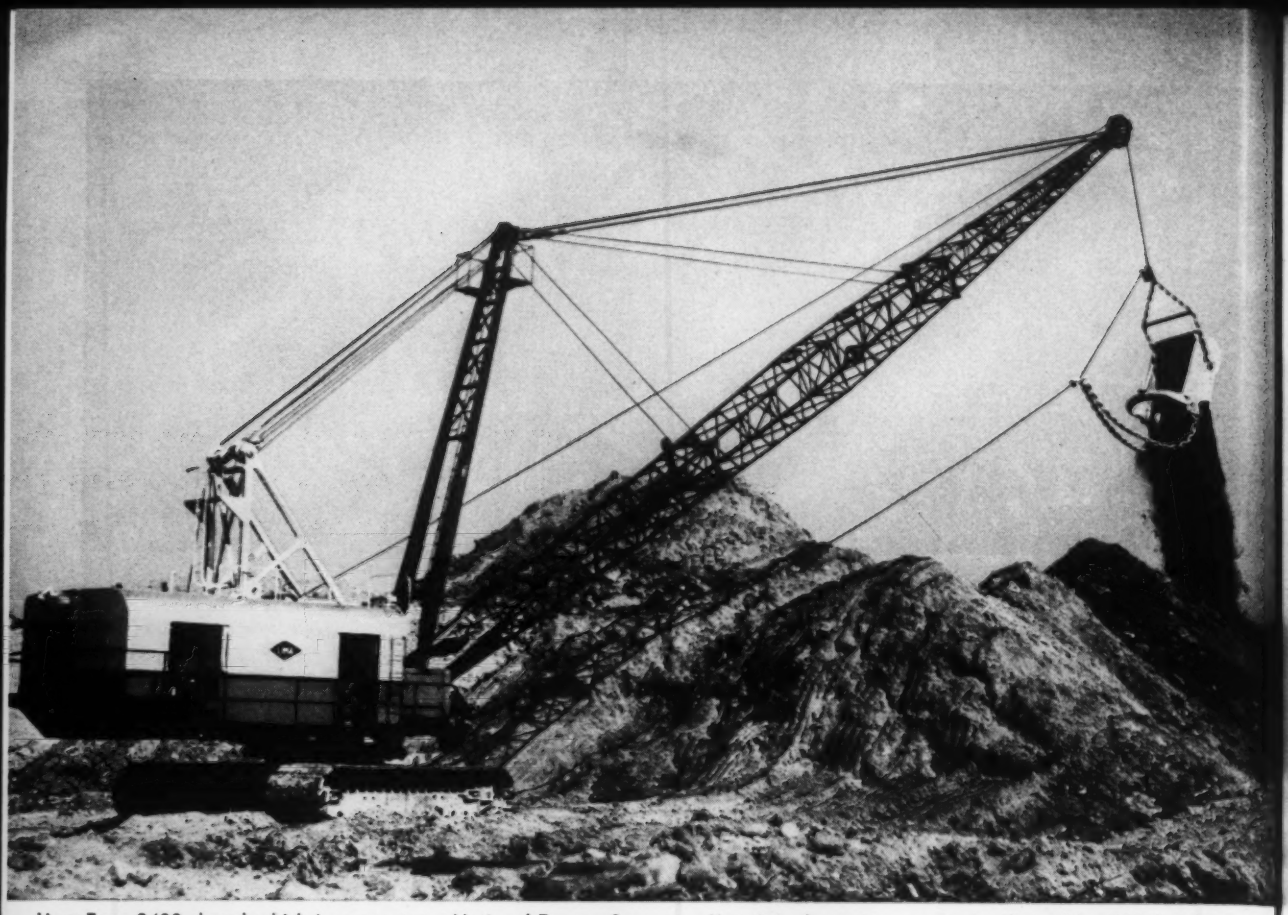

**Jones & Laughlin**
STEEL CORPORATION · PITTSBURGH

*Send for your free copy today!*

Jones & Laughlin Steel Corporation
Dept. 410, 3 Gateway Center, Pittsburgh 30, Pa.
Send me a copy of your new Cold Drawn ELECTRICWELD booklet.

NAME_____
TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE____ STATE_____


Circle 553 on page 19



Lima Type 2400 shovel which incorporates a National Torque Converter. Here it is shown in use as a dragline with a 120-foot boom.

## *Where can you use NATIONAL Torque Converters?*

National Torque Converters were developed specifically for the toughest, roughest industrial service. They are designed to provide a high degree of flexibility in operation of such equipment as power shovels, drag-lines, cranes, graders, shovel loaders, drilling rigs, mining and logging equipment.

In starting to move or lift a heavy load, a National Torque Converter acts as an automatic stepless transmission. Starts are smoother, easier . . . and acceleration of the load is faster. Result: more work per unit per operator per day.

Equipment is easier to operate and can be controlled more precisely. And there is less likelihood of overloading an engine or motor, or stalling it.

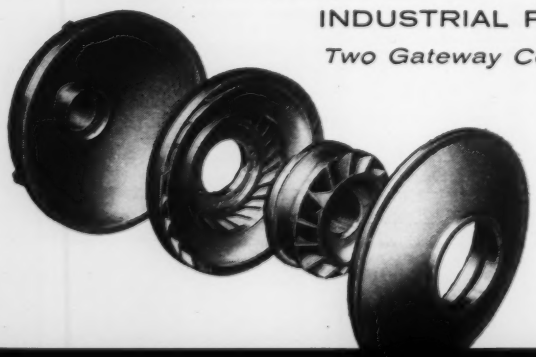
National Torque Converters are available in 6 basic hydraulic circuit sizes, each with a range of input ratings, permitting exact matching of torque converter to specific power-speed characteristics of a prime-mover. Precision fabrication of parts made to close tolerances assures uniform efficiency in operation, permitting standardization on your equipment.

Experienced National engineers are prepared to work with you on matching the right National Torque Converter to your requirements.

**THE NATIONAL SUPPLY COMPANY**

INDUSTRIAL PRODUCTS DIVISION

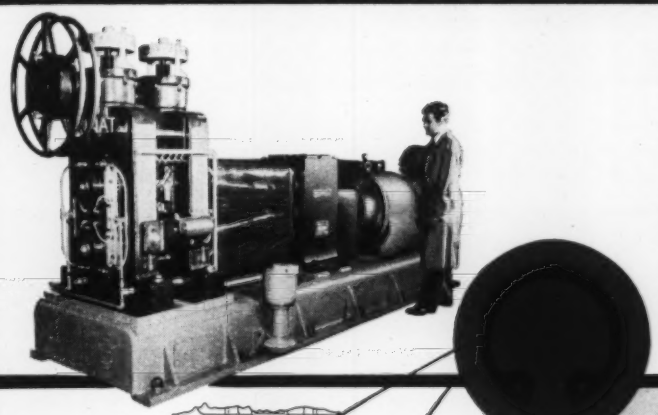
*Two Gateway Center, Pittsburgh 22, Pa.*



*Pace-setters in the progress of industrial power transmission*

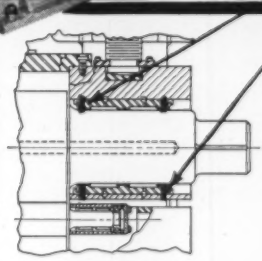
Circle 554 on page 19

# 7-inch Waldes Truarc retaining rings cut costs, speed assembly-disassembly of 2-high/4-high mill

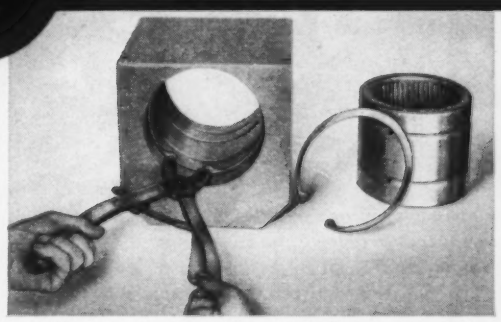


New Model TA-625 2-high/4-high combination rolling mill designed by Stanat Manufacturing Co., Long Island City, N. Y., reduces 2½" ingot to precision-rolled strip as thin as .001".

Waldes Truarc retaining rings help make possible a complete change of work rolls in 20 minutes...solve difficult problems of accuracy control by achieving positive location of bearings to extremely close tolerances. Rings eliminate costly parts and machining, save space, reduce maintenance.



In the assembly illustrated above, 7" Waldes Truarc (Series 5000) retaining rings—three on each roller—are used to position heavy-duty needle bearings in the bearing housing. Smaller rings position bearings in other roller assemblies and retain the shaft of a dual handwheel screwdown. All in all, 18 Waldes Truarc rings are used in the mill. They replace machined shoulders, spacers and lock nuts...eliminate costly threading, other machining operations.



Assembly is simple, even with giant 7" diameter Truarc ring. Special Truarc ratchet pliers grasp the ring securely, ease it into the groove, snap it securely into position. Smaller pliers and various high-speed assembly jigs are available for other rings, permit assembly-disassembly to be performed rapidly even by unskilled labor.

**Whatever you make,** there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. Quick and easy to assemble and disassemble, they do a better job of holding parts together. Truarc rings are precision-engineered and precision-made, quality controlled from raw material to finished ring.

**36 functionally different types**...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

**More than 30** engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

**For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!**

**WALDES TRUARC® RETAINING RINGS**

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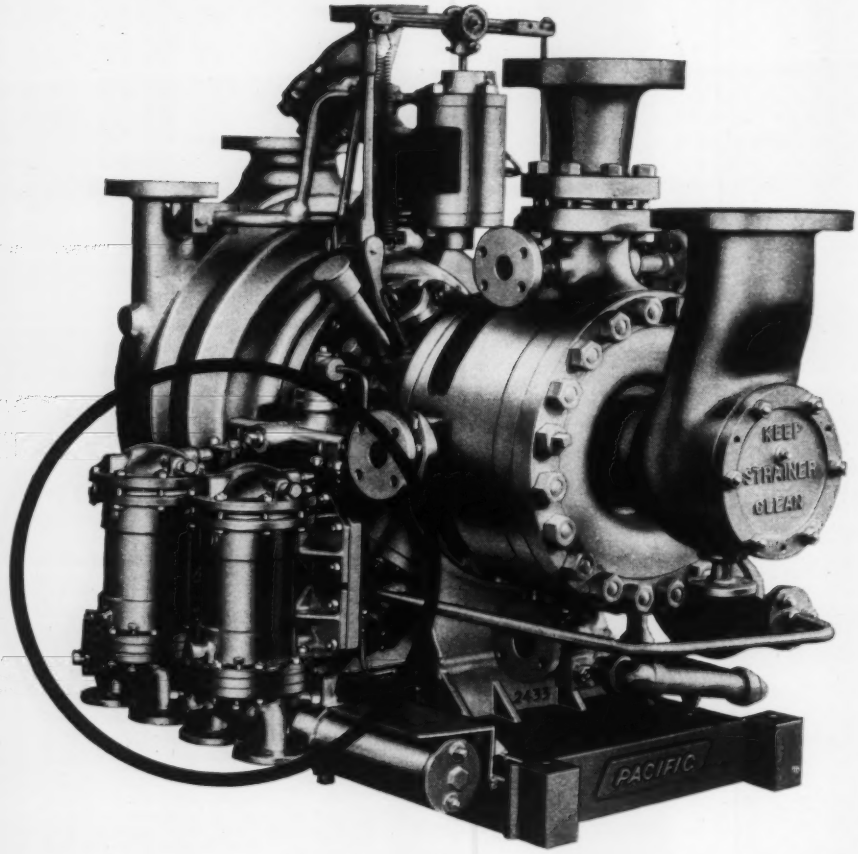
MD 108

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.




# 2 RUGGED ROSS EXCHANGERS

## insure effective lubrication of this Pacific Steam Turbopump

Delivering 152,600 lbs. of feed water hourly at 250° F. against a discharge pressure of 750 psig, this Pacific Steam Turbopump is equipped for continuous temperature safety in seagoing service.

Furnished as part of its lubricating system is a pair of Ross Type BCP Exchangers. Main and thrust bearings, as well as the worm and gear for the governor drive, are sure to receive an adequate supply of properly cooled lube oil *at all times*.

Regularly specified to meet exacting marine requirements, Ross Exchangers have long proved their seaworthiness on engines, compressors, boiler feed pumps, blowers, reduction gears and hydraulic clutches . . . cooling air, oil, water and hydraulic fluid. Both easy to install and maintain, Ross Exchangers provide the utmost in thermal efficiency and ruggedness. Pre-engineered and fully standardized, they're available in a wide range of sizes to answer *your* needs.

For detailed information, request Bulletins 2.2K1 and 2.1K1. Ross Heat Exchanger Division of American-Standard, Buffalo 5, N. Y. In Canada: American-Standard Products (Canada) Limited, Toronto 5, Ont.

ROSS

ROSS HEAT EXCHANGER PRODUCTS



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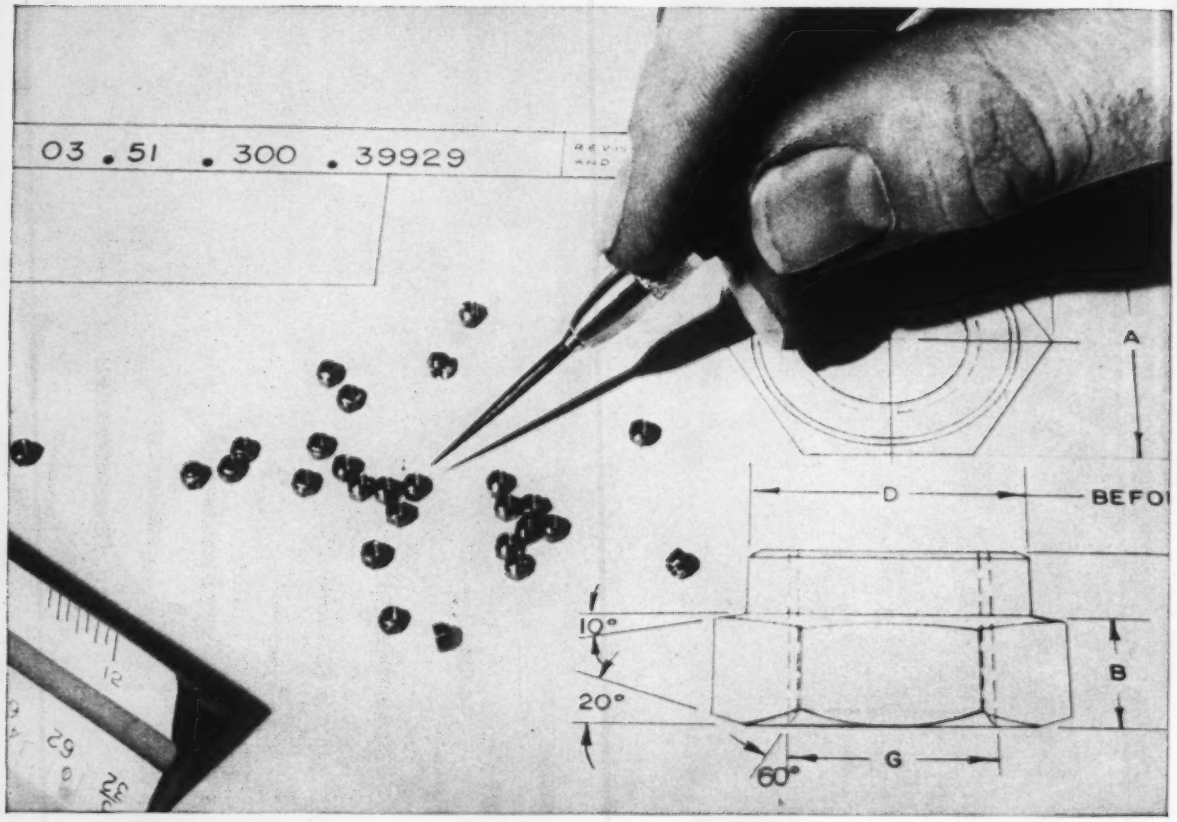
Circle 557 on page 19→

THE shape of things to come is often seen in the aluminum extrusions being made by Revere for the country's manufacturing leaders. These are the companies that know how great a difference may exist between the design of a new shape on paper and the delivery of a fine extrusion in aluminum. They come to Revere for the experience and service needed to bridge this gap. It will pay you, likewise, to gear the progress of your business to the most dependable sources of supply.

Revere Aluminum Mill Products include extruded shapes, tube, rod and bar; coiled and flat sheet, embossed sheet, circles and blanks; seamless drawn and welded tube; rolled shapes; electrical conductors; forgings; and foil. Call the nearest Revere Sales Office now. In all principal cities. Revere Copper and Brass Incorporated. Founded by Paul Revere in 1801. Executive Offices: 230 Park Avenue, New York 17, N. Y.



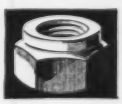

**FLEXLOC MICROSIZE** locknuts meet designers' needs for tiny precision nuts that retain strength and holding power in the smallest assemblies—servomechanisms, electronic and electrical equipment, all miniature devices.

# New FLEXLOC Microsize Locknuts

## Now available in Alloy Steel, Stainless Steel, Brass and Aluminum for lighter, more compact designs

| SIZE | Across Flats | | Shoulder Height | | Across Corners | Height +.000 −.003 |
|---|---|---|---|---|---|---|
| | MAX. | MIN. | MAX. | MIN. | MIN. | |
| 0-80 NF-3B | .111 | .107 | .047 | .042 | .123 | .075 |
| 1-64 NC-3B | .127 | .123 | .0635 | .0585 | .141 | .090 |
| 1-72 NF-3B | .127 | .123 | .0635 | .0585 | .141 | .090 |
| 2-56 NC-3B | .158 | .153 | .068 | .063 | .176 | .105 |
| 2-64 NF-3B | .158 | .153 | .068 | .063 | .176 | .105 |
| 3-48 NC-3B | .190 | .183 | .071 | .066 | .210 | .120 |
| 3-56 NF-3B | .190 | .183 | .071 | .066 | .210 | .120 |
| 4-40 NC-3B | .190 | .183 | .072 | .067 | .210 | .120 |
| 4-48 NF-3B | .190 | .183 | .072 | .067 | .210 | .120 |

**SPECIFICATIONS:** Available in brass (plain or cadmium plated) and aluminum (plain or chemically treated), for temperatures to 250°F; alloy steel, 18-8 stainless, for temperatures to 550°F.



New FLEXLOC Microsize locknuts are smaller and lighter than regular FLEXLOCS of the same nominal diameter. Wrenches of smaller size are used to install them. Mating joints or flanges can be designed smaller—with no loss in strength or convenience of assembly.

Microsize FLEXLOCS have all the advantages of larger FLEXLOCS. One-piece, all-metal construction—nothing to put together, come apart, lose or forget. Use them as lock or stop nuts—they stay put anywhere on a threaded member as soon as the locking threads are fully engaged. Uniform locking torques insure accurate preloading. There are no nonmetallic inserts to pop out or deteriorate. Moisture, dryness, oil won't affect these Microsize FLEXLOCS. Just screw them on. They lock and stay locked. Vibration won't shake them loose.

For complete information on Microsize FLEXLOCS, consult your authorized SPS distributor. Or write STANDARD PRESSED STEEL CO., Jenkintown 18, Pa.

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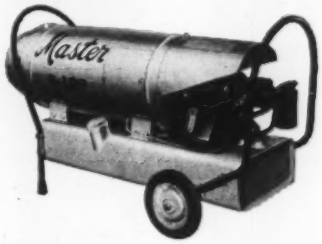
FLEXLOC® LOCKNUT DIVISION SPS JENKINTOWN PENNSYLVANIA

**Master B-100 Portable Space Heater**
MANUFACTURED BY MASTER VIBRATOR COMPANY DAYTON, OHIO



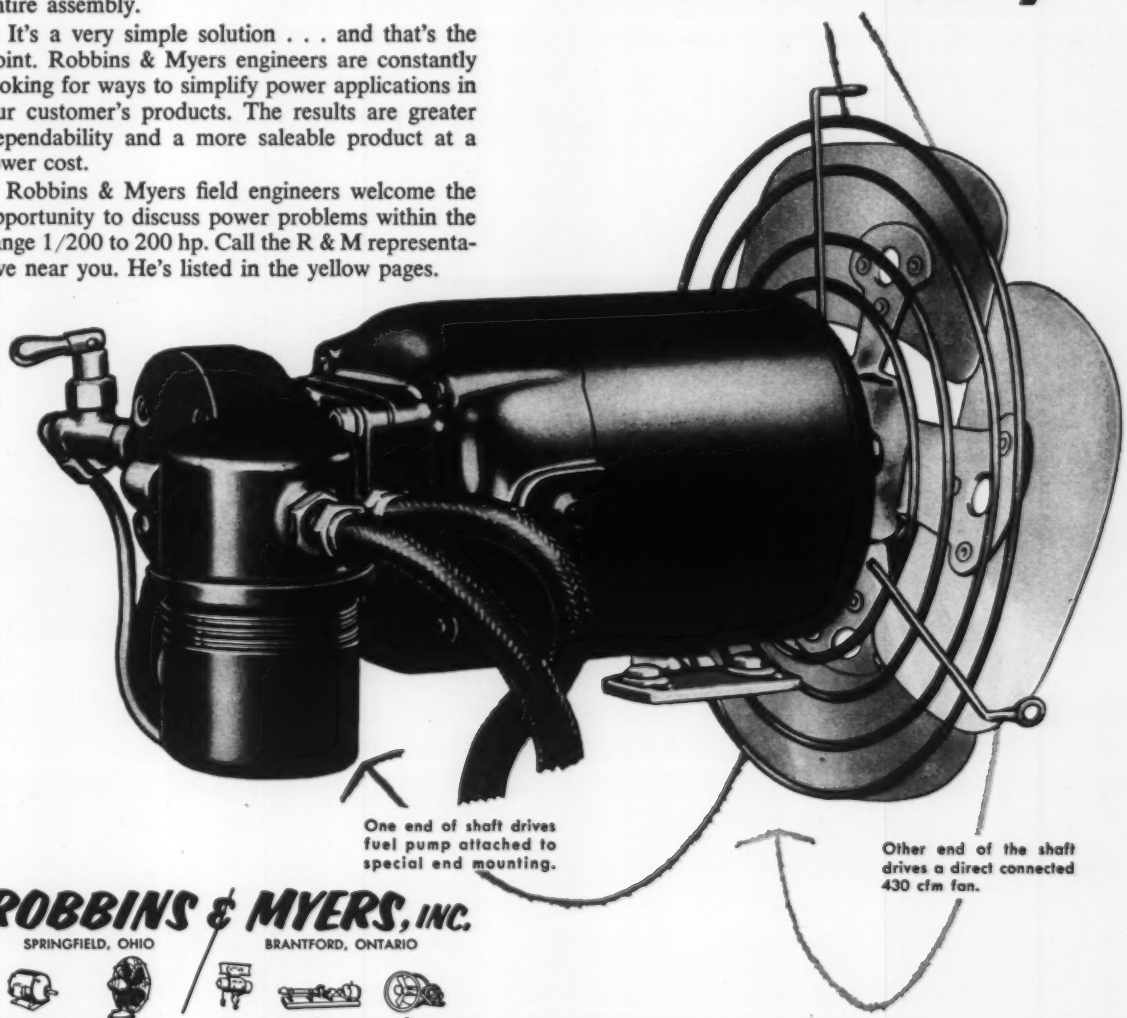

# R&M motor does double duty

To accomplish compactness, simplicity and lower cost, this enclosed ¼ hp., 3450 rpm split phase Robbins & Myers motor was specially designed to do two important jobs in the Master B-100 Portable Space Heater.

A special face mounting accommodates a direct driven fuel pump. The other end of the shaft drives a direct connected fan with an output of 430 cfm. A rigid foot mounting on the motor supports the entire assembly.

It's a very simple solution . . . and that's the point. Robbins & Myers engineers are constantly looking for ways to simplify power applications in our customer's products. The results are greater dependability and a more saleable product at a lower cost.

Robbins & Myers field engineers welcome the opportunity to discuss power problems within the range 1/200 to 200 hp. Call the R & M representative near you. He's listed in the yellow pages.



One end of shaft drives fuel pump attached to special end mounting.

Other end of the shaft drives a direct connected 430 cfm fan.

**ROBBINS & MYERS, INC.**
SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

Circle 559 on page 19

# SPEED KING

## the only valve guaranteed against coil burnout for life

Now—for the first time—you can eliminate coil burnout, the major source of valve trouble. That's because Speed King valves are *guaranteed against coil burnout for the life of the valve*. Unique design of Speed King valves minimizes inrush and holding current in solenoid coils. Furthermore, coils are encased in molded epoxy resin . . . proof against moisture, oil, dust and vibration.

And the Speed King gives you many other "plus" advantages, too. Users report Speed Kings regularly operate over 20 million cycles. In addition to being guaranteed dependable, Speed King valves are built to JIC standards . . . are compact . . . easily adapt to any requirements for air, hydraulic or vacuum applications . . . have full line of optional attachments . . . *and are available for immediate delivery from stock.*

Check your valve requirements critically. Check performance, features, materials, guarantee, delivery. Compare—and you'll specify Speed Kings. Valvair Corporation, 454 Morgan Avenue, Akron 11, Ohio.

Double solenoid Speed King shown. Single and double solenoid types in ¼, ⅜, ½, ¾ and 1" pipe sizes for steel, aluminum and molded construction. All six valves exhibit tested water quality.

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Circle 560 on page 19

MACHINE DESIGN
October 4, 1956

# Operation Paper Dolls

PAPER, scissors, and paste can keep a couple of kids out of trouble for most of a rainy day. And the same facilities may even keep a design—or a designer—out of trouble.

Operation Paper Dolls! Silly? Well, amusing at first thought, but helpful. Look at "Cardboard Mock-ups" beginning on the next page to see what we mean.

But this subject raises a basic question. In design, well-established routes from problem to answer are often the best and safest. But in adhering to the tried and proved, how often are we overlooking the simpler way? How often are we leaning on the "traditional" technique or being bound even by "professional dignity"? Or are we only being unimaginative, failing to find or use the simple ways that produce more practical answers more quickly?

Mock-up techniques, time and error-saving drafting or duplicating methods, a slide-rule calculation instead of an answer from a ten-bank calculator—such things typify the simple or easy ways that can often produce more-than-adequate answers.

Any means that speed the creative process seem to be more than justified by the results. And one of the results, which most of us will accept eagerly, is greater personal effectiveness.

Operation Paper Dolls! Silly? Or is it?

Ben Hummel

ASSOCIATE MANAGING EDITOR

*Want to try out a design idea in a hurry?*
*Here's one way—inexpensive, easy-to-make*

# Cardboard Mock-ups

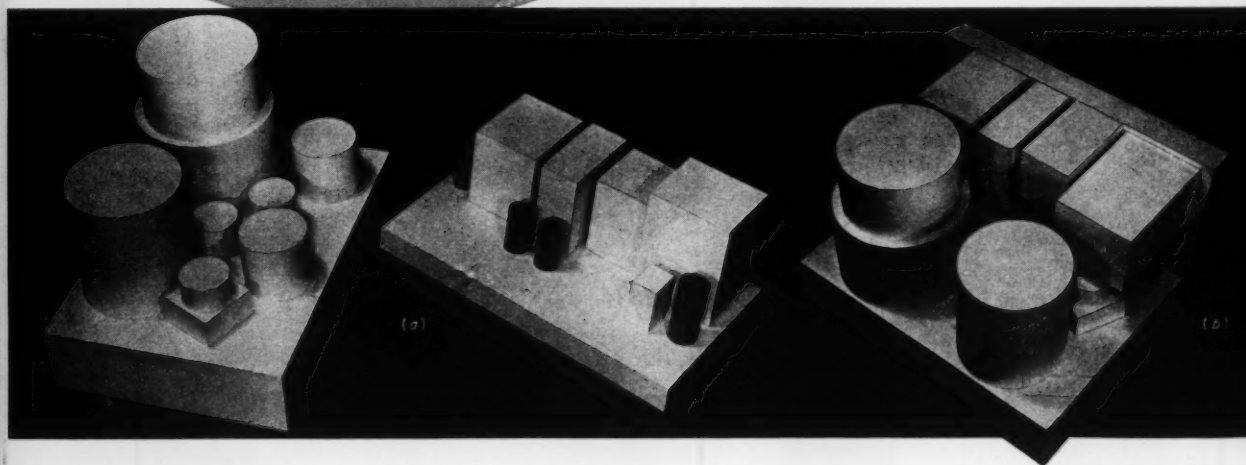
**Mock-ups are useful in proving a design after completion. But they can help the designer even more in early creative stages.**

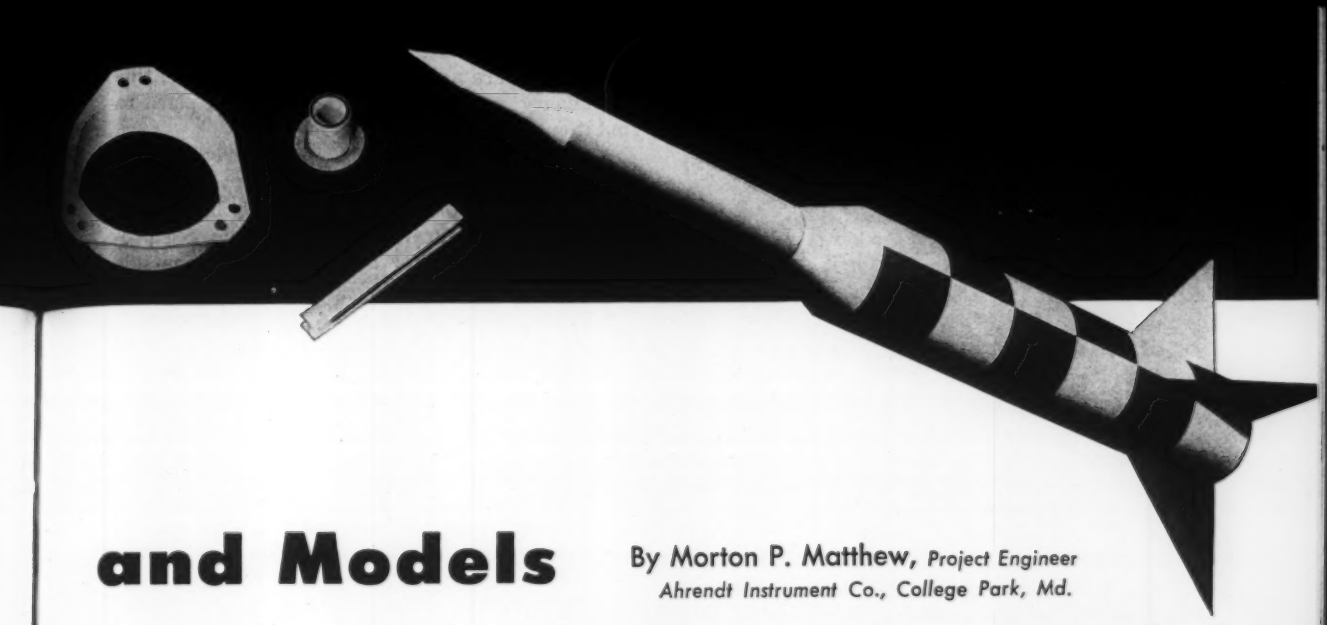
**Cardboard is particularly practical for all kinds of models. Tools are simple and few. Workspace, material and equipment needs are modest. The cardboard "model shop" can be located right in the design office, at the elbow of the designer himself.**

**The only other requirement is a certain amount of craftsmanship. Basic fabrication techniques, however, are easy. These techniques, plus the necessary equipment and material, are described.**

WHY USE cardboard for making models? Other materials commonly used are certainly satisfactory. But cardboard has special advantages to design engineers. Models made by conventional model shops generally require the use of machine tools. By contrast, cardboard requires only simple cutting and fabricating. There is no need for power tools, large work areas, or extensive supplies of assorted (and expensive) stock. The model shop can be near or in the hands of the designer himself. Little more than a large table is required for space. This means that cardboard is ideal for quick, on-the-spot trial or visualization of the essence of an idea. Cardboard models can do more than show a completed design. They can contribute creatively to its engineering.

Cardboard models are extremely light in weight. In large models this fact is a considerable advantage. They can be strong and durable. On several occasions paper models have been mistaken for





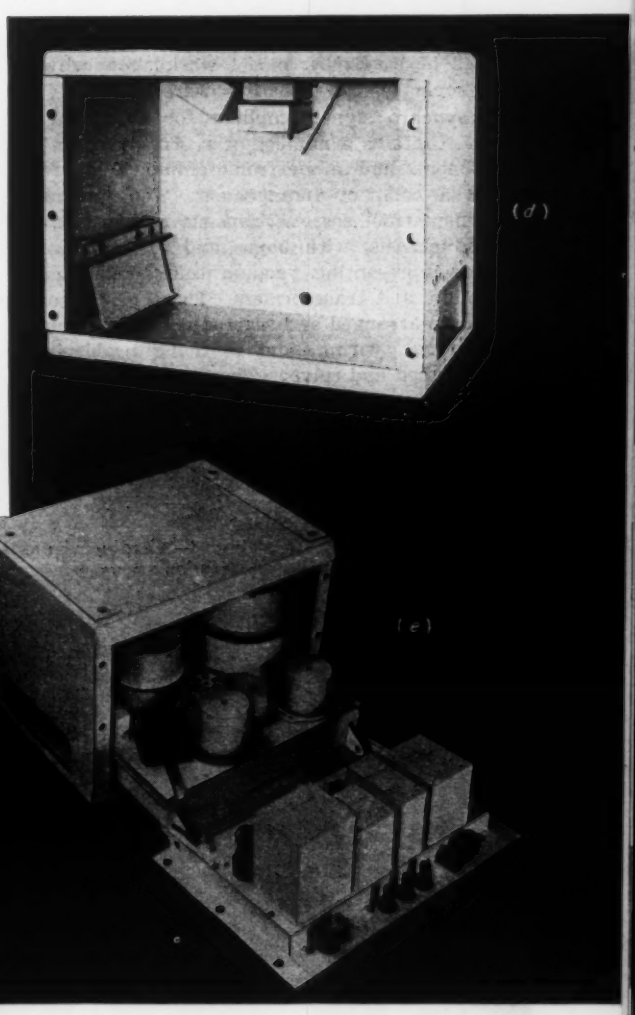
# and Models

By Morton P. Matthew, *Project Engineer*
*Ahrendt Instrument Co., College Park, Md.*

wood or plastic. And cardboard has properties of uniformity and formability that make it very suitable for certain types of detail.

These reasons justify the use of cardboard. But the chief advantage to a design group is to make the modelling a part of the department; mock-ups can be well on their way to completion in the time it takes to furnish drawings to the model shop and have the work estimated and scheduled.

**Typical Uses for Cardboard Models:** A few ex-



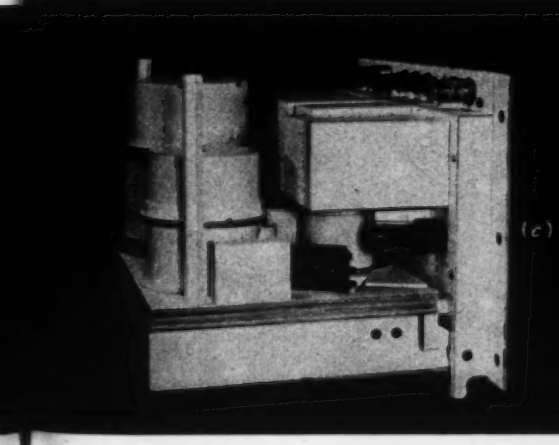




Fig. 1—Cardboard mock-up of a synchro signal amplifier. Preliminary model, *a*, consists of synchronous rotating components on base, left, and electronic amplifier, right. The mock-ups are shown in true relative position at *b*. Final cardboard mockups, made after the design was fixed are shown at *c*, cardboard case at *d*, and complete assembly at *e*.



XUM

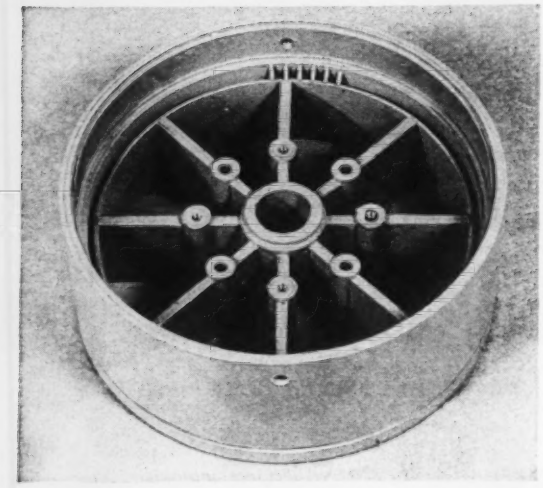


Fig. 2 — Potentiometer housing, 5 in. in diameter, made of cardboard. Mock-up was used to help decide method of manufacture. Note simulation of tapped holes by nuts inserted in the cardboard.

amples of cardboard model work show why and how some typical mock-ups were made.

A synchro signal amplifier for shipboard use, Fig. 1, contains a number of synchronous rotating components and an electronic amplifier, all mounted in a compact arrangement. The preliminary amplifier model, Fig. 1*a*, consists merely of a box-shaped chassis, with boxes and tubes of correct outline representing vacuum tubes, relay, choke, capacitor, and transformers. These model components are arranged and rearranged until mounting, interference, wiring, and servicing problems are fully studied and solved. Then the components are cemented in place.

The two chassis assemblies, shown separately in Fig. 1*a*, are shown together in final relative position in Fig. 1*b*. In a tight package like this, if any parts are not placed to best advantage, this preliminary model stage is the time and place to find it out.

After the design for the amplifier was fixed, more accurate and realistic models were made, Figs. 1*c* through 1*e*. These were of help in estimating costs, in visualization by engineering and production people, and for display to people outside the company.

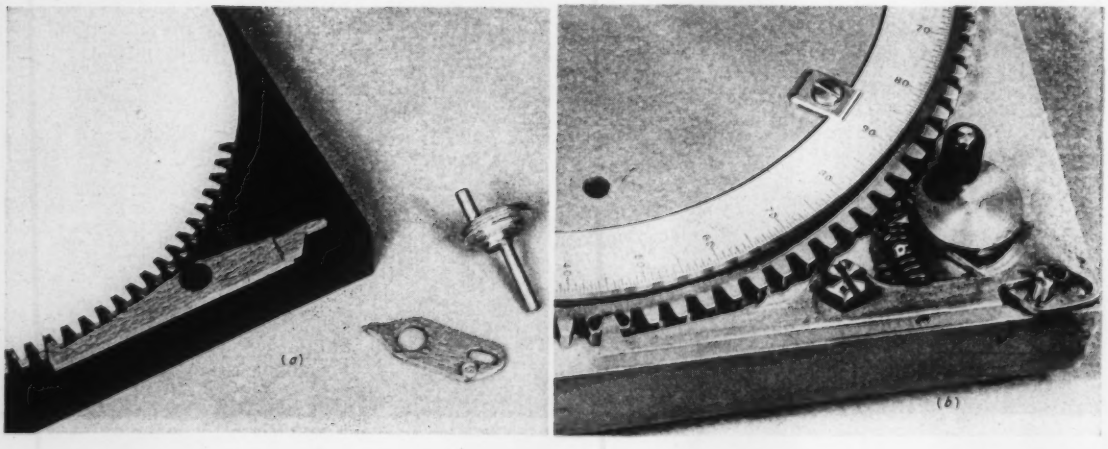
A potentiometer design had a "housing problem." Whether to use a plastic molding, a die casting, or a machined housing was the question. In obtaining estimates and opinions, the cardboard sample in Fig. 2 saved time and words in conveying thoughts and answering questions.

An indexing mechanism for an angle checking device in cardboard, Fig. 3, proved an idea, assisted detail draftsmen, and gave the feel of the operation even before the mechanism was drawn. This is an example of a working assembly with moving parts, for which cardboard is well suited.

**How to Make Cardboard Models:** Good cardboard mock-ups require nothing extraordinary in the way of skill. Nor is elaborate equipment necessary. Minor model miracles can often be worked with little more than scissors and tape. Much more, however, can be done with an ordinary trimming board, and particularly with two simple cutting devices: a slitting board and a circle cutter, developed by the writer in the process of building many such models. These tools, described later, have proved of real merit both in saving time and in producing mock-ups of a sophisticated quality.

The fundamental shapes—disks, cylinders, rectangular boxes—are relatively easy to make. Cubes and box shapes, Fig. 4, are readily fabricated from cardboard pieces properly cut, scored, folded and cemented. The modelmaker can build a nearly perfect cylinder, Fig. 5, from cardboard disks and tubes. Similarly, a multitude of other shapes common in engineering design practice can be accurately simulated using ordinary cardboard as a

Fig. 3—Cardboard model, *a*, and final metal assembly, *b*, of indexing mechanism for a potentiometer.



working medium. Wheels, tubes, shafts, disks, cones, plates, rings, flanges, cams, levers, housings, beams and weldments, in stationary or in working combination, represent only a few of the possibilities inherent in cardboard.

SLITTING BOARD: Box construction, although possible with conventional tools, is helped tremendously by a slitting board. As shown in Fig. 4, this board has a bed and rear scale like those on a conventional trimming board. But in place of the shear knife, it has a sharp blade mounted in a block which moves along a metal guide. This guide is laterally rigid.

To slit the work, first push the cutter block down on it, then push it toward the rear. The blade slits as it moves. After cutting, the guide and block spring upward, clear of the work. The device can make inside cuts for slots and apertures. Length of cut can be measured by using scale markings on the guide. An important feature of the device is its cutting-depth adjustment, which makes it possible to score, or cut partially through the work. This makes neat and accurate folding possible.

CIRCLE CUTTER: For holes and disks, a good circle cutter is essential. This can be quite simple. It should have a block, a blade clamped at one

## Fig. 4—Constructing a Box

**1. Cut and score blank.**

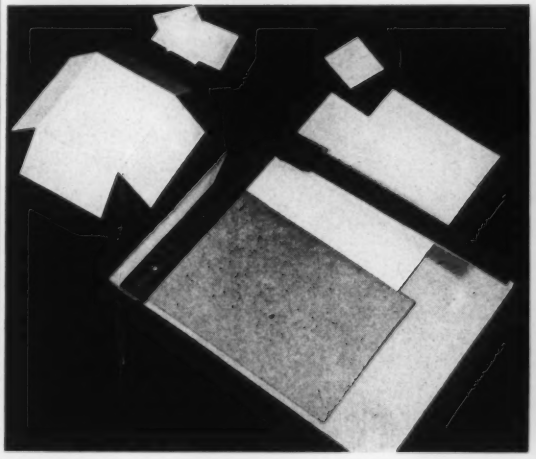
Cut a rectangle which includes the top and four sides minus two material thicknesses in each direction. Then staple a piece to the soft bed of the slitting cutter to act as a stop. This stop is located a distance equal to the height of the box less two material thicknesses from the cutting blade. The rectangle is scored on all four sides.

**2. Cut out corners; cut out second blank.**

The four corners are cut completely out. A second blank is made from a rectangle which is six material thicknesses shorter and narrower than the exact size. The blank is scored as in step 1, and corners are cut out.

**3. Fold blanks; glue together.**

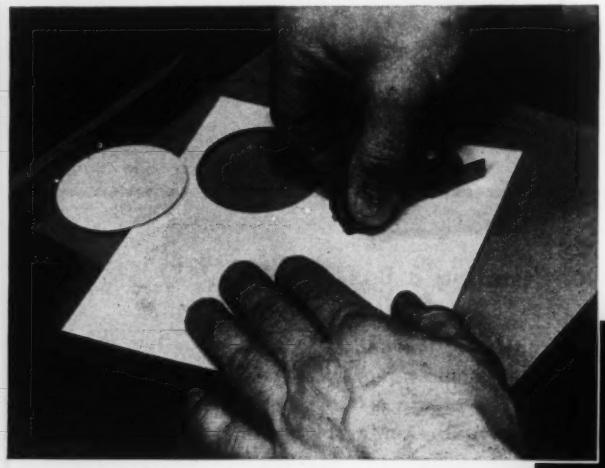
Both blanks are folded, scored side out. Cement one blank within the other to form a rigid box, using a clear waterproof cement. A rubber band holds the assembly together until it dries.



end, and an adjustable center point, Fig. 5. The pivot is a needle fixed to a bar which is adjustably clamped by a nut and thumbscrew. It cuts circles as small as 5/32-in. diameter. When the needle bar is mounted "outboard," circles 8 in. in diameter can be cut. Longer needle bars can extend the range still farther. With this tool, used in conjunction with a soft base like the slitter bed, disks can be swept out as quickly as a compass could draw them. This cutter and the slitter use blade bits (broken up razor blades) that are readily replaced.

SPECIAL TECHNIQUES: The two chassis boxes in Fig. 1 were constructed as described in Fig. 4

## Fig. 5—Constructing a cylinder



**1. Cut two disks.**

**Cut two disks with the circle cutter, two material thicknesses smaller in diameter than the finished cylinder.**

**2. Cut and curl cylinder wall strip.**

**Cut a straight strip the width of the cylinder length, and somewhat longer than the cylinder's circumference. Cut it "short grain," since paper and cardboard bend more easily this way. Curl the strip by drawing it around a rod or dowel.**

**3. Cut wall strip to proper circumference.**

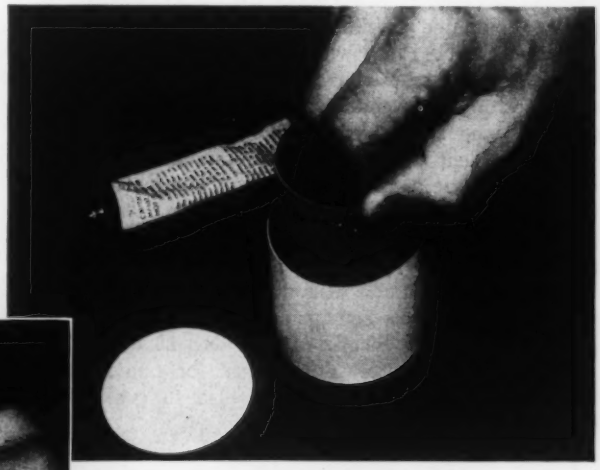
**Holding the strip in a close wrap-around fit to one of the disks, make an accurate pencil mark at the point of overlap. Cut the strip off squarely at the point of overlap.**

**4. Curl ends of strip again.**

**Additional curling, especially at the ends, insures a smooth butt joint.**

except that, because of their size, a large trimming board supplemented the slitter, and the top surfaces were each reinforced by a second thickness cemented inside.

To make cylinders more authentic as model motors or synchros, provide, as needed: (1) concentric holes when cutting the disks, for inserting a shaft; (2) a laminated stack of smaller disks, at one end for a piloting shoulder; (3) laminated rings fitting around the cylinder for a mounting flange; (4) one or more additional cylinders joined to the original where diameters



**5. Tape the cylinder joint.**

**Butt the ends of the strip to form a tube and hold as shown. Use gummed (water - softening) paper tape applied to the inside to hold the joint.**

**6. Push one disk to the bottom.**

**Using a dowel or pencil, push one disk through the tube to the bottom. Fit should be close to perfect.**

**7. Cut and insert spacer strip.**

**Cut a second strip, narrower than the first by the total thickness of the two end disks. Curl it, mark circumference, and cut length as above (close fit is not as essential, but helps rigidity). Roll it and cement it in the tube.**

**8. Insert top disk.**

**Work the second disk into place at the top of the tube to complete the cylinder.**

change. Some of the Ahrendt-built mock-up synchros even have tapped holes (in the form of embedded nuts) so that actual mounting and wiring can be done. Sometimes these detailed subunits can be used many times over for different mock-ups.

In the potentiometer case model, Fig. 2, several layers of disks and rim pieces were built up, and the open end held with a circular form until firm.

The circle cutter was used to good advantage in the eccentric hand crank shown in Fig. 3. This was built of laminated circular disks, some on and some off center. Rods were made of rolled-up paper; this is often faster than finding, cutting, and smoothing a wooden dowel. Additionally, paper rods and tubes have a peculiar advantage. Until the cement dries, their diameters are "adjustable," and size or fit in a given hole is a matter of choice.

The toothed index plate in Fig. 3 was made of laminated disks, cut and notched separately, using the slitting board. Each disk was pivoted on the bed and rotated a marked amount between short straight cuts. (Time for six laminations, 28 teeth in each: 1 hr.) Accuracy is sufficient for smooth operation in this mechanism, and also in gears made this way.

**Materials and Finishes:** The best all-around cardboard for models is probably six-ply (approximately 1/32-in.) process blanks, or railroad board, which comes in colors. It is available in stationery stores. White coated blanks, eight, six, four and three-ply, may be purchased in paper supply houses and art supply stores. They have different names and different properties among different manufacturers.

These smooth-coated boards can be sprayed or brushed with enamel or lacquer. Silver or aluminum lacquer is excellent. Lacquer is probably more satisfactory than enamel, since it dries quickly and has less tendency to cause warping. A light coat also helps reduce warping tendencies. However, warping is not usually a problem except with large, thin, flat, unsupported pieces. In this case, finishing both sides equally helps.

Thicker, softer, uncoated cardboard can be used for the inner layers when laminating, but 3/64-in. approaches the maximum thickness workable with the tools described. These cheaper, softer boards are known quite universally as "chipboard" or "newsboard." This board takes a somewhat poorer finish and works best sandwiched between the better grade board.

Bristol board is too thick to cut or curl easily. Moreover, any board coated on only one side has a greater tendency to warp. For rolled-up paper tubes and rods, construction paper is readily available and inexpensive. Even laundry shirt cardboard and cereal boxes need not be ruled out completely. But don't count on hiding printed matter with anything but black or aluminum.

For cementing, Duco cement has proved so satisfactory that the writer has never tried any other. Ordinary gummed paper tape is the most satisfactory kind. The use of masking tapes or other pressure-sensitive tapes is to be discouraged. They can't be slid into place like moistened gummed tape. They tend to slip gradually under stress. Warmth and finish solvents can soften them. Gummed tape stays put when dry and is unaffected by heat or solvents.

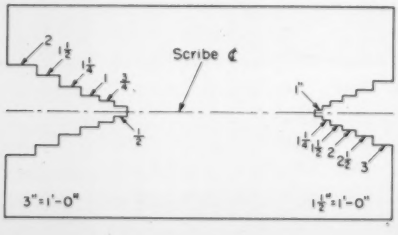
**Conclusion:** Cardboard need not be limited to small models. The 4-ft scale model of a proposed three-stage satellite rocket shown at the beginning of this article was recently constructed for use in photographs. A 7-ft high oil-refinery pump model was built some years ago for an International Petroleum Exposition. A complete gas turbine has been made of cardboard.

Measured by cost and amount of tools and equipment, work space needed, material supply, cleanliness, and close-at-hand availability, cardboard is hard to surpass in model work. It deserves an important place in design departments where mock-ups can be used to frequent advantage.

# Tips and Techniques

## *Pipe Sizes Template*

A great deal of time can be saved when making piping drawings by making a plastic template similar to that shown to cover most commonly used scales and sizes.—CHARLES J. GUTHRIE, *George J. Meyer Mfg. Co., Cudahy, Wis.*

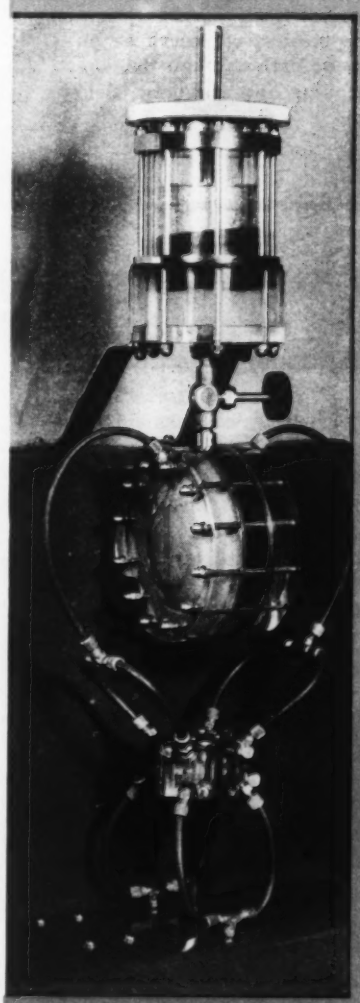


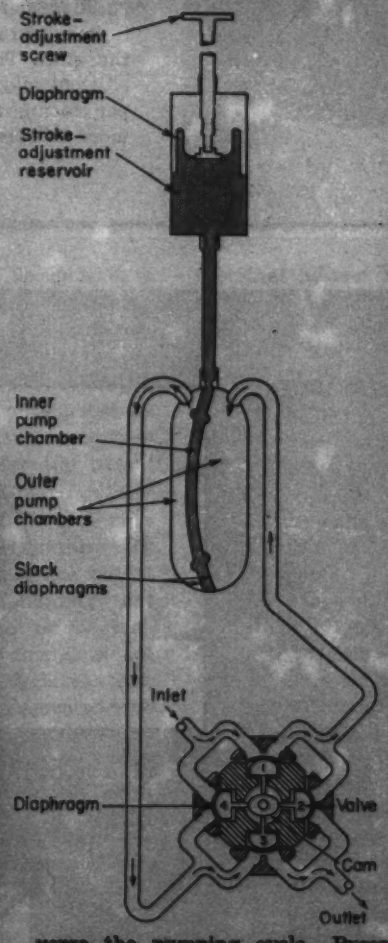

## *Preserving Centers*

When a number of concentric circles are drawn, the center hole in the drawing paper usually becomes enlarged, thus destroying accuracy. A small piece of celluloid or plastic fastened to the drawing with masking tape at the center point will eliminate this problem.—H. M. CAMERON, *Armour Research Foundation, Chicago, Ill.*

# scanning the field for Ideas

**MULTIPLE-DIAPHRAGM CONSTRUCTION** in a novel fluid meter design eliminates need for stuffing boxes or close-clearance fits and prevents fluid-to-metal contact. Used in Milton Roy's Minus Delta P controlled-volume "pump", which is a positive-displacement meter for "downhill pumping" of liquids or gases, the design provides a completely leak-proof metering system.



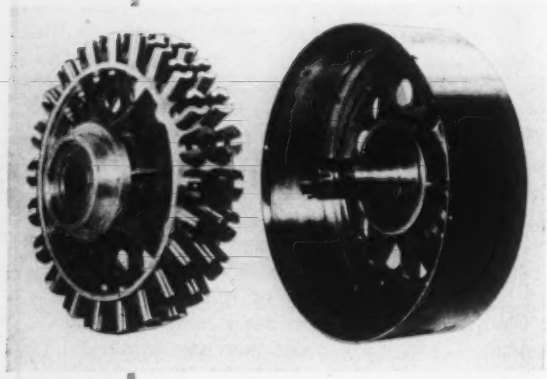



In design the pump is made up of three units: a pump chamber, a four-way valve, and a stroke-adjustment reservoir. The pump chamber is divided into three parts by two slack diaphragms. The valve, which contains four cam-operated diaphragms, is connected to the inlet and outlet sides of the line and to the outer pump chambers. The stroke-adjustment reservoir, which also contains a diaphragm, is connected to the inner pump chamber.

In operation the four-way diaphragm valve alternately admits fluid to each side of the diaphragm pumping chamber. As fluid enters one side of the pump chamber, fluid is simultaneously discharged from the opposite side. When the cam rotates a quarter turn, valves 1 and 3 close while valves 2 and 4 open to reverse the pumping cycle. Pump capacity depends on the effective volume of the pump chamber. This volume is controlled by the amount of fluid displaced from the stroke-adjustment reservoir into the inner pump chamber, between the two slack diaphragms.

# IDEAS

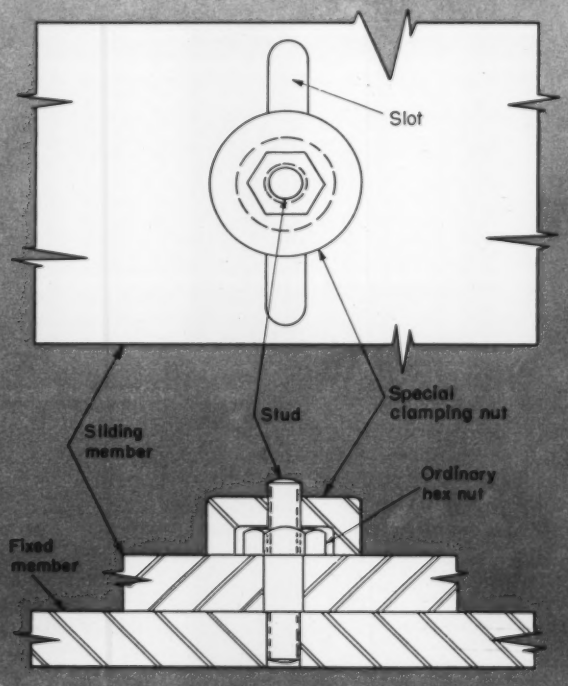
**PERMANENT-MAGNET ROTOR** construction eliminates the need for separate electrical excitation of the rotor field in a magnetic slip-coupling design. Developed by Tormag Transmissions Ltd. (Canada) and licensed to the Whitney Chain Co. for manufacture in this country, the coupling design consists essentially of a driven magnetic rotor and a driving bimetallic rotor. The magnetic rotor is a cylinder to which are attached a large number of Alnico V permanent magnets. The bimetallic rotor consists of a mild-steel cylinder faced on the inside with copper and perforated with two rows of steel rivets.



The magnetic rotor is mounted inside the bimetallic rotor cylinder, and the two rotors are separated by an air gap. Driving either rotor causes the permanent-magnet rotor to induce an eddy-current field in the bimetallic cylinder, and a torque is developed between the two rotors. The eddy currents are produced primarily in the copper facing since it is a better electrical conductor than the steel. The steel rivets serve as an efficient magnetic path through the copper facing making the magnetic field more effective.

**CONCENTRIC - NUT ASSEMBLY** provides both clamping and controlled-clearance sliding of machine members. Developed by A. D. Roubloff of the Farnham Mfg. Div., Wiesner-Rapp Co. Inc., for a machine slide, the fastener consists of a stud, an ordinary hex nut for holding a sliding member, and a special design clamping nut. The unthreaded portion of the stud is larger in diameter than either of the threaded ends. Thus the shouldered stud can be locked by screwing it into a threaded machine member and the hex nut can be locked against the shoulder on the other end. Amount of sliding clearance is determined by how much the height of the unthreaded portion of the stud exceeds the thickness of the sliding member.

The special clamping nut, made from hex stock or round bar, permits clamping the sliding member without changing a preset sliding clearance.



*Facts about*

# Domestic Patent Applications and Foreign Patents

- basic rule
- time limitation
- disclosure requirements

By Albert Woodruff Gray
*Forest Hills, N. Y.*

OVER half a century ago, a decision in a patent-infringement action came for review before the United States Supreme Court. In the defense to this action, it had been maintained that the patent of a belting fabric was invalid since the invention had been anticipated by the use of this same fabric in England more than two years before the application for the patent had been filed in this country.

**Basic Rule:** In that decision is contained the rule of law and the interpretation of the patent statute that is the law today. "Conceding that there was sufficient evidence of the use of such belting in England, we think that this does not vitiate the patent. [The statute] declares that, 'Any person who has invented or discovered any new and useful art, machine, manufacture or composition of matter, or any new and useful improvement thereof, not known or used by others in this country and not patented or described in any printed publication in this or any foreign country before his invention or discovery thereof and not in public use or on sale for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of fees required by law and other due proceedings had, obtained a patent therefore.'

"Taking all these provisions of the patent law together we think it was manifestly the intention of Congress that the right of the patentee to his invention should not be denied by reason of the fact that he had made use of it or put it on sale abroad more than two years before the application, provided it were not so used or sold in this country."

**Time Limitation:** In the patent law enacted in 1952, no essential change was made from the provisions of this law of 1870 beyond the substitution of one year for the two-year limitation in the former statute from the granting of the foreign patent within which the patent application must be filed in this country.

This restriction, however, against the granting of a patent application for an invention that has

been patented or published in a foreign country more than a year before has been restricted by the courts to instances in which the disclosure either in the patent issued or the printed publication of a foreign country, is clear, specific and leaves nothing to conjecture.

**Clarity of Disclosure:** Recently an appeal was

before the federal court for review from a decision in an infringement action holding to be valid a patent for, "A spiral wheel or rotary hoe, comprising a disc having a hub and two series of angle-steel pointed teeth, of the respective series being located on opposite sides of the disc and lying against and secured to the outer surface of the disc, whereby the teeth of one series are arranged in alternation to those of the other series."

In the defense to this lawsuit, it was asserted that this patent had merely followed the teachings, among others, of a patent granted long before by the French government. In reversing the decision of the lower court and holding this patent invalid because of its anticipation by this foreign patent, the court said,

"A foreign patent is competent to anticipate a domestic patent if it teaches the invention with sufficient clarity to enable those skilled in the art to understand its nature and to carry it into practical use without further experimentation.

"It is true that to be an anticipation the disclosure of a prior patent, even a domestic patent, must be clear and we may assume for present purposes that the rule must be more strictly applied to foreign than domestic patents. Nevertheless if the descriptions and drawings of a foreign patent disclose the invention in terms so full and clear as to enable a person skilled in the art to practice the invention without making experiments, then it will be a complete anticipation."

This statement, made here by that court, is an echo of a federal appellate court decision in an action brought by the Westinghouse Air Brake

Co. against the Great Northern Railway Co. many years ago for an infringement of air-brake patents in which it was claimed in the defense that the patents were invalid by reason of patents for the same invention already issued in England.

"The prophetical suggestions in the English patents of what can be done when no one has ever tested by actual and hard experience and under the stress of competition, the truth of the suggestions of the practical difficulties in the way of their accomplishment, or even whether the suggestions are feasible, do not carry conviction of the truth of these frequent and vague statements."

Another restriction in the application of these provisions of the patent law is that a domestic patent is invalid by so much as it is anticipated by a foreign patent that is a clear and definite exposure of the invention.

In an action brought several years ago for the infringement of patents of open-hearth and reverberatory furnaces used in smelting copper ore, it was contended that these patents had been anticipated by a British patent issued 50 years before.

Here the federal court pointed out that this British patent had been a failure, had never been put to use and that if the invention of sloping side walls in the reduction chamber ever had been adopted in a reverberatory furnace, it would have been a failure.

"A foreign patent is to be measured as anticipatory, not by what might have been made out of it but by what is clearly and definitely expressed in it. An American patent is not anticipated by a prior foreign patent unless the latter exhibits the invention in such clear, full and exact terms as to enable any person skilled in the art to practice it without the necessity of making experiments."

**Nature of Disclosure:** Another feature that has been held to limit the effect of foreign inventions is that, unless there is a publication, the mere use or reduction to practice of a discovery outside of the United States does not affect the right of the inventor to a patent in this country.

Application for the patent of an invention, a plurality of motors in combination with a vehicle, mechanically connected to the driving wheels of the vehicle and under the control of the motorman, was filed in this country on June 28, 1905. On February 6 of the following year the patent was granted.

In Hungary an engineer had made this same discovery some time before 1904, and in that year the invention had been in actual use on the Valtellina Railroad in Italy. This Hungarian inventor in the spring of that year had given to an American an elaborate and detailed description of the invention and the American had later described the invention at a convention of the American Institute of Electrical Engineers. Application for a patent for this Hungarian invention was filed in the Patent Office in this country on July 3, 1906, approximately five months after the patent on the same invention had been issued for the American invention.

At that time, the provision of the patent statute, section 4923, which was substantially the same as in the present statute, was,

"Whenever it appears that the patentee at the time of making his application for the patent believes himself to be the original and first inventor or discoverer of the thing patented, the same shall not be held to be void on account of the invention or discovery, or any part thereof, having been known or used in a foreign country, before his invention or discovery thereof, if it had not been patented or described in a printed publication."

In the litigation that followed this confusion, the owners of the Hungarian invention contended for their right to a patent since that discovery antedated that of the American invention. In its de-

nial of this contention, the federal court said of the application of this provision of the patent law,

"Section 4923 deals specifically with the effect of knowledge and use in a foreign country and it makes no distinction whether such use is made or such knowledge is acquired by persons who, after using the thing or acquiring the knowledge, remain abroad or come here. This section provides that the patent taken out by an applicant for the same thing here shall not be void on account of such knowledge or use unless the invention has been patented or described in a printed publication.

"As we construe this section reduction to practice in a foreign country can never operate to destroy a patent applied for here, however widely known such reduction to practice may be, either among foreigners or among persons living here, unless the invention be patented or described in a printed publication."

**Other Disclosure Requirements:** An early instance of the tendency of the courts in this country to minimize the disclosures of a foreign publication either by print or patent occurred in a suit brought for the infringement of a machine for removing hair from fur skins. Two foreign patents were interposed by the defense in the attack on the validity of the American patent claimed to be infringed.

"They are insignificant and indeterminate and fail to add anything of importance to the controversy," said the court. "It is enough that it is impossible to formulate any definite explanation of the working of the machine. A document so obscure in its terminology that two conflicting theories may be deduced therefrom and supported by equally plausible arguments is too indefinite to be utilized as an anticipation."

When a few years ago the commissioner of patents refused a patent on a hydraulic testing machine on the ground that the invention had been anticipated by a German publication, suit was brought to compel the issuance of the patent.

In this German publication, apparently the catalog of a manufacturer, was the statement, "Hydraulic universal material testing machine—Model M P 4. For tension, compression, buckling, binding, folding, punching, and Brinell tests, chain and spring tests, creep tests, etc.," followed by detailed dimensions and a general description.

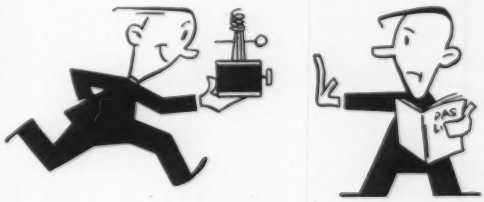
In holding here that this general and indefinite description was not a printed publication within the meaning of the patent statute, the federal court said,

"The consideration of a foreign publication relied upon as a reference against a claimed invention must be in the light of the law, relating to such a publication. It is not competent to read into a foreign publication any information which it does not afford on its face. The disclosure of a foreign publication must be so clear that it teaches the subject matter of the patent in suit without assistance from the latter."

Here the court referred to a case before the Supreme Court over 75 years ago. There suit had been brought for infringement with the defense that the patent was void since it had been anticipated by disclosure in an article in an English periodical, the *Mechanics Magazine*. Of the inadequacy of the disclosure the court said,

"Patented inventions cannot be superseded by the mere introduction of a foreign publication of the account, though of prior date, unless the description and drawings contain and exhibit a substantial representation of the patented improvement in such full, clear and exact terms as to enable any person skilled in the art or science to which it appertains, to make, construct and practice the invention to the same practical extent as they would be enabled to do if the information was derived from the prior patent.

"Mere vague and general representations will not support such a defense, as the knowledge supposed to be derived from the publication must be sufficient to enable those skilled in the art or



science to understand the nature and operation of the invention and to carry it into practical use. Whatever may be the particular circumstances under which the publication takes place, the account published, to be of any effect to support such a defense, must be an account of a complete and operative invention capable of being put into practical operation."

Adopting this old decision as authority, the United States Court of Appeals recently restated the law long ago announced by that higher court. "No doctrine of the patent law is better established than that a prior patent or other publication, to be an anticipation, must bear within its four corners adequate directions for the practice of the patent invalidated. If the earlier disclosure offers no more than a starting point for further experiments, if its teaching will sometimes succeed and sometimes fail, if it does not form the art without more how to practice the new invention, it has not correspondingly enriched the store of common knowledge and it is not an anticipation."

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1. Gandy v. Main Belting Co., 143 *U.S.* 587.
2. Allied Wheel Products v. Rude, 206 *Fed.* 2d 752.
3. Westinghouse Air-Brake Co. v. Great Northern Railway Co., 88 *Fed.* 258.
4. Carson v. American Smelting & Refining Co., 4 *Fed.* 2d 463.
5. Westinghouse Machine Co. v. General Electric Co., 207 *Fed.* 75.
6. Cimmiotti Unhairing Co. v. Comstock Unhairing Co., 115 *Fed.* 524.
7. Seymour v. Osborne, 78 *U.S.* 516.
8. Dewey & Almy Chemical Co. v. Mimex Co., 124 *Fed.* 2d 986.

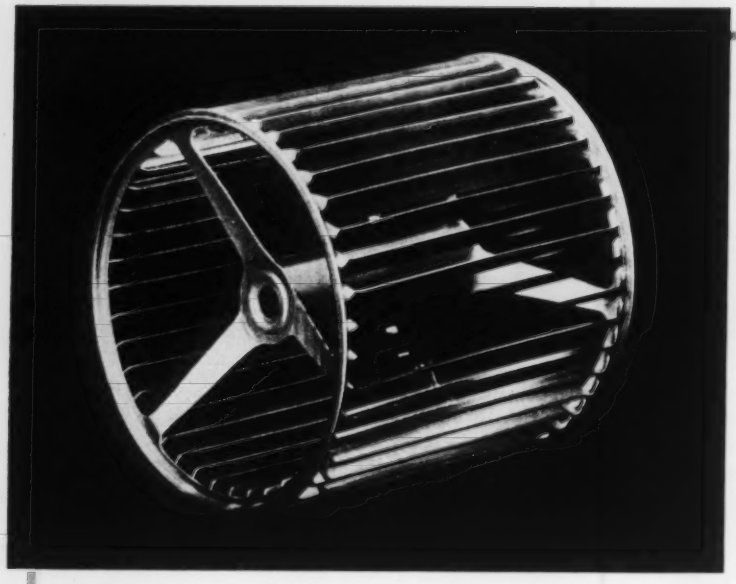
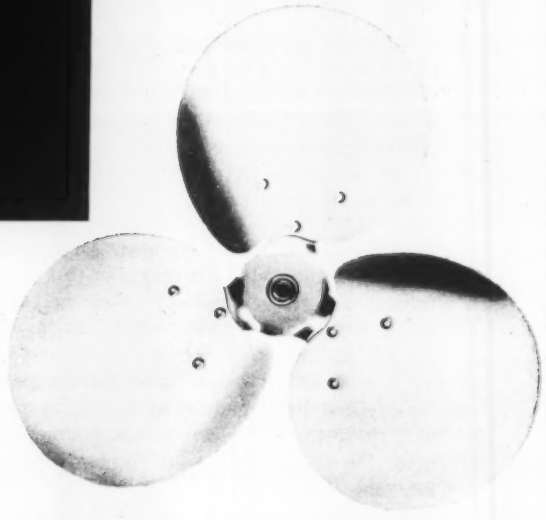


Fig. 1 — Left—Typical centrifugal impeller.

Fig. 2—Below—Typical axial impeller.



By Charles A. Hathaway
*Chief Engineer, Air Impeller Div.*
*Torrington Mfg. Co.*
*Torrington, Conn.*

# *How to select*

# AIR IMPELLERS

AIR IMPELLERS are available today in such a variety of types, sizes and designs that that there may be some question whether the designer is helped or handicapped in his efforts to select the optimum impeller for a given air-moving system. Fortunately, while the combination of system operating requirements is almost always unique, the hundreds of standard models developed by impeller manufacturers usually include at least one model that satisfies the system requirements. In certain other cases—for example, where design conditions are unusual—design of a special impeller may be indicated.

The variety of standard impeller designs is most likely to become a handicap—or at least offer no advantage—whenever the designer fails to use a logical step-by-step procedure in pinpointing optimum impeller types and sizes. At the very least, the catch-as-catch-can approach involves a great deal of thumbing through manufacturers' literature. Nevertheless, it is quite likely that

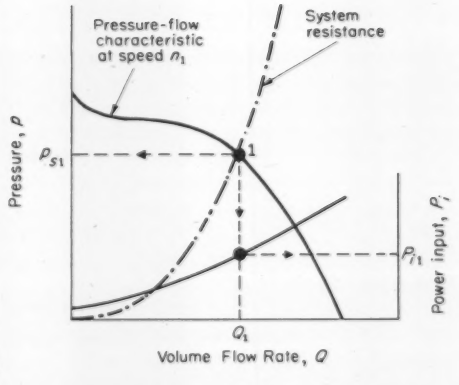



Fig. 3—Impeller static pressure, system flow resistance and input power as functions of flow rate. Point 1 is system operating point.

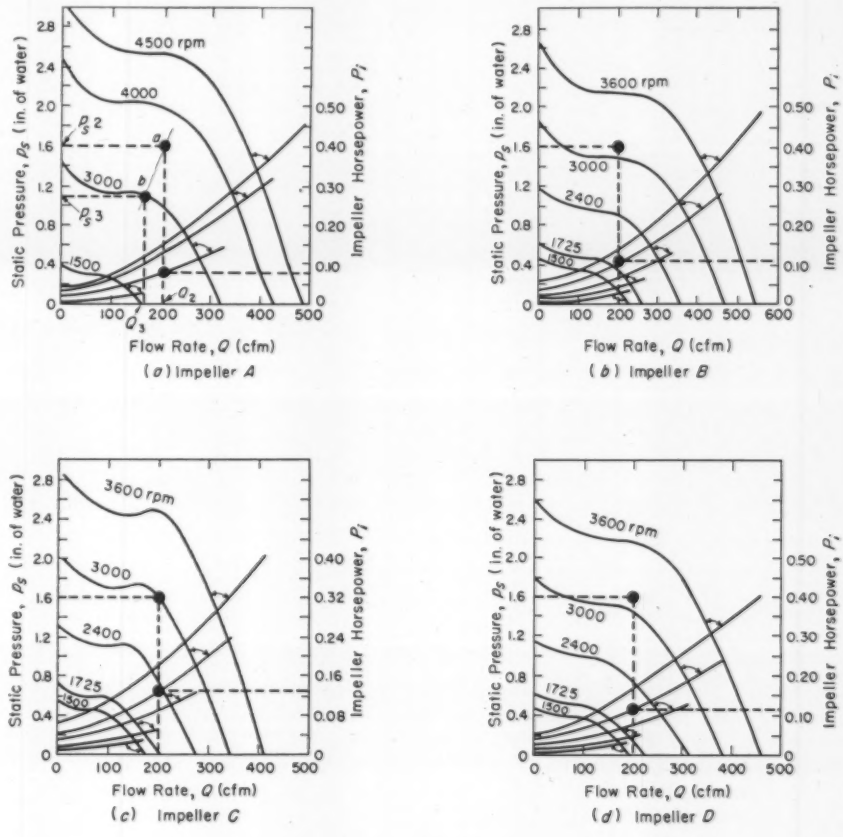



Fig. 4 — Performance curves for four representative centrifugal impellers.

# for optimum performance

the greatest waste in such unorganized selection methods is not the time lost in studying catalog data. Rather, there is the strong possibility that the impeller ultimately specified will not be the best one for the job, and the selection process will have to be repeated.

This article outlines simple step-by-step procedures for selecting the proper type and size of impeller for any given set of application requirements. Examples of the procedures are given for each of the two ways in which impeller ratings and performance characteristics are presented in manufacturers' literature.

**Performance Requirements:** As in selecting or designing any component, the engineer must first record the operating specifications and limitations on which selection of the optimum impeller is based. In an air-moving system, both performance and physical requirements must be known. Primary performance requirements are (1) rate of air flow, and (2) static pressure. Preferred magnitudes of impeller speed and motor horsepower may also be given as initial conditions.

Rate of air flow, calculated on the basis of such system considerations as heat transfer or necessary air movement, depends on the specific function of the air-moving circuit and its desired capacity. Static pressure added by the impeller (or by several impellers) must equal the sum of the pressure losses in the system at the required rate of air flow. Pressure losses due to such flow obstructions as coils or elbows and losses in ducts of various sizes and materials are available in published literature. Total pressure loss in a system, that is, system resistance, may also be determined experimentally by test.

While rate of flow and static pressure are characteristics of the air-moving system itself, a desired impeller speed is usually specified primarily as a matter of economy. Although special drive motors may be specified for high-volume produc-

## Table 1—Axial Impeller Performance

| Four-Bladed Series | Speed (rpm) | NAFM Code Test — Static Pressure (in. of water) 0 cfm | 0 hp | 0.0625 cfm | 0.0625 hp | 0.100 cfm | 0.100 hp | 0.125 cfm | 0.125 hp | 0.200 cfm | 0.200 hp | 0.250 cfm | 0.250 hp | 0.300 cfm | 0.300 hp | 0.375 cfm | 0.375 hp | NEMA Free-Air Test cfm | NEMA Free-Air Test hp |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 1050 | 620 | .009 | 535 | .013 | 455 | .016 | 375 | .018 | | | | | | | | | 905 | .012 |
| | 1140 | 670 | .012 | 595 | .016 | 530 | .018 | 475 | .020 | | | | | | | | | 980 | .015 |
| | 1500 | 880 | .028 | 828 | .032 | 790 | .036 | 765 | .037 | 650 | .045 | 540 | .052 | | | | | 1290 | .035 |
| | 1725 | 1015 | .042 | 970 | .047 | 940 | .051 | 920 | .053 | 850 | .060 | 775 | .066 | 685 | .074 | 600 | .083 | 1485 | .053 |
| B | 1050 | 720 | .012 | 650 | .017 | 570 | .020 | 470 | .021 | | | | | | | | | 1020 | .018 |
| | 1140 | 780 | .017 | 720 | .021 | 650 | .024 | 580 | .025 | | | | | | | | | 1110 | .024 |
| | 1500 | 1030 | .039 | 990 | .043 | 950 | .048 | 920 | .050 | 810 | .058 | 670 | .062 | | | | | 1460 | .053 |
| | 1725 | 1185 | .059 | 1145 | .065 | 1120 | .069 | 1100 | .072 | 1030 | .080 | 965 | .087 | 860 | .090 | 725 | .101 | 1680 | .081 |
| C | 1050 | 870 | .022 | 775 | .026 | 690 | .028 | 575 | .030 | | | | | | | | | 1240 | .027 |
| | 1140 | 940 | .028 | 860 | .032 | 790 | .035 | 730 | .036 | | | | | | | | | 1350 | .034 |
| | 1500 | 1240 | .064 | 1180 | .070 | 1140 | .073 | 1110 | .075 | 995 | .082 | 820 | .088 | 765 | .093 | | | 1770 | .078 |
| | 1725 | 1425 | .097 | 1380 | .104 | 1345 | .108 | 1320 | .110 | 1230 | .118 | 1155 | .123 | 1070 | .128 | 890 | .138 | 2040 | .119 |
| D | 1050 | 755 | .013 | 680 | .017 | 605 | .019 | 530 | .022 | | | | | | | | | 1030 | .014 |
| | 1140 | 815 | .017 | 755 | .0206 | 690 | .023 | 640 | .024 | | | | | | | | | 1115 | .019 |
| | 1500 | 1075 | .040 | 1035 | .043 | 1000 | .047 | 970 | .050 | 860 | .056 | 760 | .064 | 695 | .070 | | | 1470 | .042 |
| | 1725 | 1235 | .060 | 1205 | .064 | 1180 | .068 | 1155 | .070 | 1075 | .079 | 1010 | .085 | 925 | .092 | 820 | .103 | 1690 | .064 |
| E | 1050 | 955 | .024 | 870 | .027 | 795 | .029 | 715 | .031 | | | | | | | | | 1235 | .026 |
| | 1140 | 1040 | .030 | 965 | .034 | 895 | .036 | 845 | .038 | 660 | .045 | | | | | | | 1345 | .033 |
| | 1500 | 1365 | .069 | 1305 | .074 | 1260 | .077 | 1235 | .078 | 1135 | .085 | 1035 | .092 | 935 | .097 | | | 1770 | .076 |
| | 1725 | 1570 | .105 | 1520 | .110 | 1485 | .113 | 1460 | .116 | 1385 | .123 | 1325 | .127 | 1250 | .134 | 1110 | .145 | 2030 | .115 |
| **Three-Bladed Series** | | | | | | | | | | | | | | | | | | | |
| F | 1050 | 870 | .022 | 770 | .027 | 695 | .030 | | | | | | | | | | | 1030 | .023 |
| | 1140 | 945 | .028 | 855 | .034 | 790 | .037 | 730 | .040 | | | | | | | | | 1315 | .030 |
| | 1500 | 1250 | .065 | 1180 | .072 | 1135 | .076 | 1100 | .080 | 990 | .087 | | | | | | | 1475 | .067 |
| | 1725 | 1430 | .100 | 1375 | .106 | 1340 | .110 | 1310 | .114 | 1230 | .120 | 1160 | .128 | 1070 | .135 | | | 1700 | .103 |
| G | 1050 | 655 | .007 | 590 | .011 | | | | | | | | | | | | | 895 | .007 |
| | 1140 | 710 | .010 | 660 | .013 | 585 | .018 | | | | | | | | | | | 965 | .010 |
| | 1500 | 940 | .022 | 900 | .026 | 875 | .030 | 850 | .033 | | | | | | | | | 1270 | .022 |
| | 1725 | 1080 | .034 | 1050 | .037 | 1025 | .042 | 1010 | .045 | 935 | .055 | 835 | .060 | | | | | 1460 | .034 |
| H | 1050 | 835 | .012 | 750 | .016 | 675 | .020 | | | | | | | | | | | 1060 | .013 |
| | 1140 | 895 | .014 | 825 | .020 | 770 | .023 | 715 | .026 | | | | | | | | | 1150 | .017 |
| | 1500 | 1170 | .033 | 1125 | .040 | 1090 | .045 | 1065 | .047 | 970 | .056 | | | | | | | 1515 | .038 |
| | 1725 | 1350 | .051 | 1310 | .059 | 1280 | .064 | 1265 | .067 | 1195 | .076 | 1165 | .082 | 1050 | .092 | | | 1740 | .057 |
| I | 1050 | 995 | .019 | 910 | .025 | 855 | .030 | 800 | .032 | | | | | | | | | 1250 | .020 |
| | 1140 | 1090 | .023 | 1010 | .032 | 950 | .036 | 915 | .038 | | | | | | | | | 1355 | .025 |
| | 1500 | 1420 | .053 | 1360 | .062 | 1330 | .064 | 1305 | .070 | 1210 | .082 | 1120 | .092 | | | | | 1610 | .056 |
| | 1725 | 1630 | .082 | 1570 | .094 | 1530 | .100 | 1510 | .105 | 1455 | .116 | 1420 | .122 | 1370 | .132 | | | 1850 | .085 |
| J | 1050 | 1150 | .028 | 1070 | .038 | 1000 | .042 | 940 | .058 | | | | | | | | | 1470 | .035 |
| | 1140 | 1260 | .038 | 1170 | .047 | 1115 | .052 | 1070 | .054 | | | | | | | | | 1600 | .044 |
| | 1500 | 1650 | .087 | 1590 | .100 | 1550 | .105 | 1530 | .110 | 1430 | .120 | 1350 | .126 | 1240 | .130 | | | 2100 | .100 |
| | 1725 | 1900 | .132 | 1850 | .150 | 1815 | .160 | 1790 | .164 | 1720 | .174 | 1660 | .180 | 1600 | .186 | 1490 | .190 | 2420 | .152 |

tion at little additional cost, it is normally good design practice to select a standard power unit. Speeds obtained with two, four and six-pole split-phase motors and comparable shaded-pole motors are frequently specified. Higher motor speeds are generally specified when compactness is important; lower motor speeds are usually used to obtain quieter operation. Because required performance may not be obtained with an impeller of the desired size operating at the preferred motor speed, changes in speed or some other operating characteristic may be necessary.

**Physical Requirements:** Space available—both size and shape—and orientation of the impeller intake and discharge are physical requirements that influence impeller selection. Of the two basic impeller types, the centrifugal impeller, Fig. 1 discharges air at right angles to its intake. In an axial impeller, on the other hand, air flow is continuous from intake to discharge, Fig. 2. With no such requirement on flow orientation, it is possible that the engineer may not know at this point in the selection procedure whether the best impeller will ultimately be a centrifugal or axial type. However, in designing revised models of standard equipment—for example, packaged air conditioning units or ventilators—the designer may know the most appropriate impeller type from experience. Nevertheless, the design should be verified for each new application.

Because space is at a premium in most air-moving units, there are very few impeller applications where there is not a definite limit on the space assigned to the impeller. Thus, diameter and width of a centrifugal impeller, including housing or scroll dimensions, must be considered in relation to the space available. In axial impellers, blade-tip diameter and total axial length of impeller and motor may be critical. In vane-axial impellers, space occupied by guide vanes and diffusers can be limiting.

**Standard Performance Data and Prototype Tests:** Performance data published by impeller manufacturers are based on tests conducted under standard conditions specified by industry codes. The NEMA free-air test represents the performance of free-air impellers, which are designed to circulate air within the space in which they operate. Many industry associations have developed procedures for testing centrifugal and axial im-

pellers operating under positive pressure rather than with zero static pressure as in the free-air impeller test. These test procedures are followed by most impeller manufacturers in developing performance data for all types of impellers, whether they are common, three-bladed house fans or specialized, high-efficiency vane-axial impellers.

Performance data based on standard testing codes should be considered only as guides in impeller selection. Thus, while optimum impeller type and size may have been most carefully selected, operation of the air-moving system can only be truly evaluated by testing a prototype. Differences between actual operating conditions and the ideal conditions used to establish ratings must, of course, be considered.

In addition to listing important dimensions of each impeller model, manufacturers' catalogs also give dimensions for standard housings, vanes and diffusers on which the performance data are based. Any deviation from these standard dimensions and designs usually changes the published data.

**Two Types of Performance Data:** Representative performance for an impeller operating at constant speed is represented by the upper curve in Fig. 3, which gives static pressure as a function of air flow rate. For a given impeller, similar curves can be obtained at each speed that is considered to be of interest. As shown in Fig. 3, motor horsepower required to drive an impeller at constant speed may also be given as a function of flow rate. These two curves then represent, for example, the values of static pressure $p_{s1}$, impeller horsepower $P_i$, flow rate $Q_1$ and speed $n_1$ for that type and size of impeller operating at point 1 on this performance curve.

Impeller performance data are presented either in the form of plotted curves, Fig. 4, or in tabular form, Table 1. Performance curves are more commonly used today simply because they describe more completely the operating characteristics of the impeller and provide a clearer picture of the relation between impeller and system characteristics.

**Static Efficiency:** Total or mechanical efficiency is the ratio of total air-horsepower output to impeller horsepower. Total air-horsepower output consists of static and velocity components. Because complete usage of the velocity component is never realized in most applications, engineers prefer to apply a more conservative quantity called static efficiency.

Static efficiency $\eta_s$ is the ratio of static air horsepower output (based on static pressure $p_s$ alone) to impeller horsepower $P_i$ and is given by

$$\eta_s = \frac{Q\, p_s}{6356\, P_i}$$

Because the magnitude of static air horsepower is fixed by performance requirements, a major objective is certainly to minimize power input by

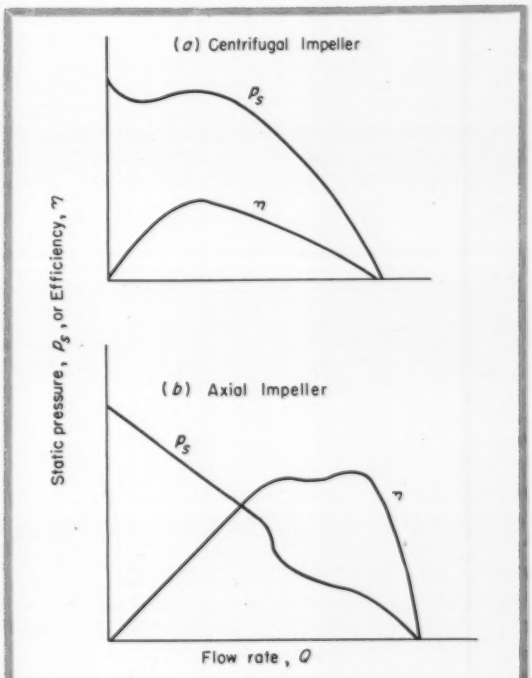



Fig. 5—Above—Static pressures and static efficiencies of typical centrifugal and axial impellers.

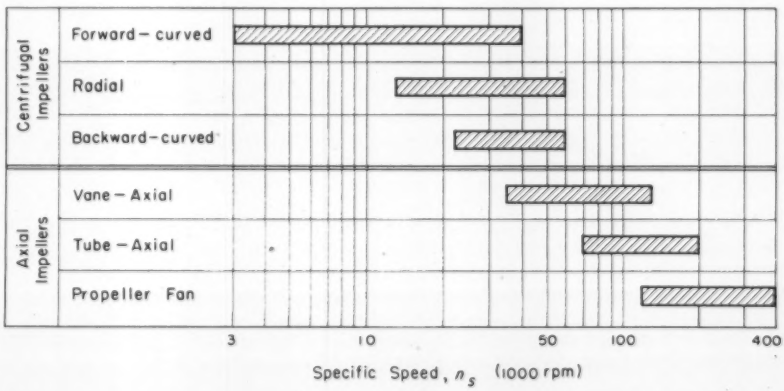



Fig. 6—Left—Ranges of specific speed in which six types of centrifugal and axial impellers operate at high static efficiencies.

selecting an impeller that will operate at or near its maximum static efficiency.

In Fig. 5, curves for both static pressure and static efficiency are given for representative centrifugal and axial impellers. Peak static efficiency for each impeller is located on the full-flow side of the stall recession just at the top of the slope. It is desirable to select an impeller whose point of operation in the application would occur as far up the slope of its static pressure curve as is possible within practical limits.

In tabular performance data, location of the stall recession, and therefore the area of higher static efficiencies, cannot be immediately determined. Therefore, the impeller fulfilling all performance requirements with the lowest test horsepower is selected as the most efficient.

**Specific Speed:** Flow rate, static pressure and speed at one point of operation on the impeller performance curve are related by specific speed $n_s$, where

$$n_s = \frac{n\sqrt{Q}}{p_s^{3/4}} \qquad (1)$$

An impeller of given type and proportions, regardless of size, has its peak static efficiency at a particular specific speed. It is possible, therefore, to specify ranges of specific speed within which each impeller type operates at comparatively high static efficiencies. Such ranges are shown in Fig. 6 for the most common types of air impellers.

Specific speed, Equation 1, can be considered a quantity that represents the performance requirements of an air-moving system. Therefore, it is logical in the selection process to determine first the specific speed required by the system and then from Fig. 6 select the one or more impeller types which can be efficiently operated at this specific speed.

**Conversion of Performance Requirements:** In using either performance curves, Fig. 4 or Table 1, the designer may find it necessary to convert performance requirements.

The conversion that is most often necessary concerns impeller speed. Both performance curves and tables cover four or five common impeller speeds in the range recommended for each impeller type. When the preferred motor speed is not one for which performance information is given, values of static pressure and flow rate required can be converted by use of the following fan laws:[1]

[1]Kenneth A. Merz—"Air-Circuit Design," MACHINE DESIGN, Vol. 28, No. 13, June 28, 1956, Page 88.

| Impeller | Impeller horsepower | Space occupied (recommended housings) a (in.) | b (in.) | c (in.) | Relative cost* | Relative quietness | Other design considerations |
|---|---|---|---|---|---|---|---|
| B | 0.17 | $7\frac{1}{4}$ | $8\frac{17}{32}$ | $4\frac{3}{4}$ | Base | — | — |
| C | 0.19 | $8\frac{3}{16}$ | $9\frac{41}{64}$ | $3\frac{1}{16}$ | +$0.35 | — | — |
| D | 0.17 | $7\frac{1}{4}$ | $8\frac{17}{32}$ | 4 | −$0.03 | — | — |

*Total cost of impeller, housing, motor, etc

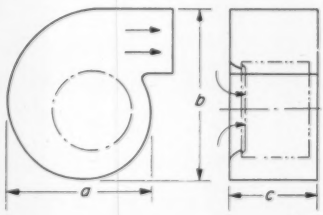



Fig. 7—Selection table for evaluating impellers B, C and D in Example 1.

| Impeller | Impeller horsepower | Space occupied (recommended orifices) Tip diameter (in.) | Axial depth (in.) | Relative cost* | Relative quietness | Other design considerations |
|---|---|---|---|---|---|---|
| C | 0.028 | 12 | $3\frac{3}{4}$ | — | — | — |
| F | 0.030 | 12 | $3\frac{31}{32}$ | — | — | — |

*Total cost of impeller, orifice, motor, etc

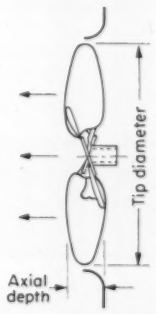



Fig. 8—Selection table for evaluating impellers C and F in Example 2.

$$Q_2 = Q_1 \left( \frac{n_2}{n_1} \right) \quad (2)$$

$$p_{s2} = p_{s1} \left( \frac{n_2}{n_1} \right)^2 \quad (3)$$

where $n_1$ is the preferred motor speed and $n_2$ is the chart motor speed to which the data must be converted. If the performance data show that a particular impeller can deliver a chart flow $Q_2$ at chart static pressure $p_{s2}$ and chart speed $n_2$, it can also deliver $Q_1$ at $p_{s1}$ and $n_1$ as specified in the original performance requirements. The actual impeller horsepower $P_{i1}$ required to deliver $Q_1$ at $p_{s1}$ and $n_1$ can be calculated from the value of horsepower $P_{i2}$ in

$$P_{i1} = P_{i2} \left( \frac{n_1}{n_2} \right)^3 \quad (4)$$

Both the free-air and the pressure testing standards are based on a standard air density of 0.075 lb per cu ft. If the air density expected in actual operation is significantly different from the stand-

## Example 1—Impeller Selection by Performance-Curve Method

Assume that the following performance requirements are known in selecting an impeller for a large commercial oil burner: $Q_1 = 230$ cfm; $p_{s1} = 2.10$ in. of water; and $n_1 = 3450$ rpm.

**Step 1:** From Equation 1 specific impeller speed is

$$n_s = \frac{3450 \sqrt{230}}{2.10^{3/4}} = 30{,}000 \text{ rpm}$$

**Step 2:** In Fig. 6, $n_s = 30{,}000$ rpm appears at the low end of the range for backward-curved centrifugal impellers and on the high end of the ranges for radial and forward-curved impellers. In view of size and price considerations, a forward-curved centrifugal impeller is selected in this example as the type which best meets given performance requirements.

**Step 3:** A cursory review of performance data on forward-curved centrifugal impellers available in this example shows that 3000 rpm is the chart motor speed nearest the required speed of 3450 rpm at which most performance data are given. Therefore Equations 2 and 3 are used to convert $Q_1$ and $p_{s1}$ at $n_1 = 3450$ to $Q_2$ and $p_{s2}$ at $n_2 = 3000$ as follows:

$$Q_2 = 230 \left( \frac{3000}{3450} \right) = 200 \text{ cfm}$$

$$p_{s2} = 2.1 \left( \frac{3000}{3450} \right)^2 = 1.59 \text{ in. of water}$$

**Step 4:** In Fig. 4, the point of operation ($Q_2 = 200$ cfm; $p_{s2} = 1.59$ in. of water) is found to be reasonably close to the performance curves at $n_2 = 3000$ for impellers *B* and *D* and virtually on the curve for impeller *C*. The actual point of operation on the performance curve for impeller *B* would be at approximately $p_{s3} = 1.44$ in. of water and $Q_3 = 190$ cfm. Similarly a parabolic curve drawn through the desired operating point for impeller *D* intersects its performance curve at $p_{s3} = 1.43$ in. of water and $Q_3 = 190$ cfm. The flow rate that would be obtained with impeller *A* is considered too low, and so it is eliminated as a possible selection. A rate of 190 cfm is on the low side but acceptable, so that impellers *B* and *D* will be evaluated with impeller *C* in Step 5.

**Step 5:** Using Equation 4, the impeller horsepower $P_{i1}$ required by impellers *B*, *C* and *D* at $n_1 = 3450$ are determined from $P_{i2}$ given for each in the curves in Fig. 4 as follows:

Impeller *B*

$$P_{i1} = 0.115 \left( \frac{3450}{3000} \right)^3 = 0.17\text{-hp}$$

Impeller *C*

$$P_{i1} = 0.125 \left( \frac{3450}{3000} \right)^3 = 0.19\text{-hp}$$

Impeller *D*

$$P_{i1} = 0.115 \left( \frac{3450}{3000} \right)^3 = 0.17\text{-hp}$$

These values are then recorded in the selection table in Fig. 7.

The major outside dimensions *a*, *b* and *c* for standard housings recommended by the manufacturer for use with impellers *B*, *C* and *D* are also listed in the selection table. Relative cost of the complete impeller units has been determined and recorded; quietness is about the same for each impeller because the motor would in this case operate at the same speed, 3450 rpm.

If cost were the primary design factor, impeller *D* would be selected because it produces the desired output at a total unit cost 3 cents lower than impeller *B* and 38 cents lower than impeller *C*. In this example, the higher cost of impeller *C* might be due to the need for a more expensive casting for the larger unit. The slightly lower cost of impeller *D* might be attributed to the ¾-in. saving in width over impeller *B*.

While impellers *B* and *D* both have the lower horsepower requirements, impeller *D* might be preferred because it also occupies the least volume. On the other hand, if width of the impeller housing were the limiting dimension, then impeller *C* would probably be the ultimate choice.



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ard, it may be necessary to convert to chart static pressure by use of the following expression:

$$p_{s2} = p_{s1}\left(\frac{\rho_2}{\rho_1}\right) \qquad (5)$$

where $\rho_1$ is actual air density and $\rho_2 = 0.075$. Rate of air flow is independent of density change, and impeller horsepower varies directly with density like static pressure in Equation 5.

## *How to select impellers from* Performance Curves

The following steps should be taken in selecting air impellers on the basis of performance curves like those in Fig. 4.

**Step 1:** Determine specific speed $n_s$ for the air-moving system from Equation 1 on the basis of required $Q$, $p_s$ and prefered $n$.

**Step 2:** Determine from Fig. 6 the type or types of impellers in whose ranges of specific speed the value $n_s$ calculated in Step 1 appears.

**Step 3:** If necessary, using Equations 2 and 3, convert the required $Q_1$ and $p_{s1}$ from $n_1$ to $Q_2$ and $p_{s2}$ corresponding to a chart motor speed $n_2$ which is convenient to use in the manufacturers' performance data. In considering more than one impeller type and design, it may be necessary to convert to more than one motor speed. If necessary, convert $p_s$ to correspond to the basis of standard air density.

**Step 4:** Review the performance curves for each of the impeller types determined in Step 2 for the chart speed selected in Step 3 to find those which will deliver approximately $Q_2$ at very nearly $p_{s2}$ within the normal operating range on the rise between the stall recession and free flow. In order to obtain high static efficiency, consider only those impellers for which this operating point is located quite near the top of the slope.

The space between the required operating point (at $p_{s2}$ and $Q_2$) and the performance curve which is acceptable depends, of course, on the degree of accuracy desired. In practical applications, the possible variables in the air-moving system are such that it is wasteful to be overprecise in this step of the procedure.

The curve representing the flow resistance of the particular air-moving system for which the impeller is being selected is approximately a parabola of the form $p_s = kQ^2$, such as the dotted curve in Fig. 3. It passes through the specified operating point, for example, point 1 in Fig. 3. In Fig. 4*a*, a segment of the system-resistance curve drawn through the required $Q_2$ and $p_{s2}$ at point *a* would then intersect the performance curve at the actual operating point *b*. For that particular impeller, operating at the desired speed in the known system, actual flow and pressure values $Q_3$ and $p_{s3}$ are therefore determined. The value of $Q_3$ is then compared to the required $Q_2$, and the impeller is accepted or rejected on the basis of the allowable tolerance on flow rate.

It may be found that none of the impellers that fit the performance requirements can operate in the more efficient range near the top of the slope. For this reason, or to satisfy physical requirements in Step 5, many impellers are operated satisfactorily at pressures quite far down the slope

### Example 2—Impeller Selection by Tabular Data Method

Assume that the following performance requirements are known in selecting an impeller for a small kitchen wall ventilator: $Q_1 = 690$ cfm; $p_{s1} = 0.10$-in. of water; and $n_1 = 1050$ rpm.

**Step 1:** From Equation 1 specific impeller speed is

$$n_s = \frac{1050\sqrt{690}}{0.10^{3/4}} = 155{,}000 \text{ rpm}$$

**Step 2:** Fig. 6 shows that the specific speed calculated in Step 1 coincides with the optimum operating range of a propeller fan.

**Step 3:** The desired operating speed, $n_1 = 1050$, is found to be a common chart speed for which data are given in performance tables for propeller fans, Table 1. Therefore, it is not necessary to convert $Q_1 = 690$ cfm and $p_{s1} = 0.10$-in. of water.

**Step 4:** In Fig. 5, $p_{s1} = 0.10$ corresponds to a table value of static pressure so that no interpolation is necessary.

**Step 5:** A quick review of the available performance data on propeller fans shows that a particular four-bladed series and a three-bladed series of impellers (five sizes of each series are shown in Table 1) offer ranges of performance covering the ventilator requirements. Specifically, at $n_1 = 1050$ and $p_{s1} = 0.100$-in. of water, impeller *C* in the four-bladed series provides $Q_1 = 690$ cfm and impeller *E* in the three-bladed series provides $Q_1 = 695$ cfm.

**Step 6:** Impeller horsepower for impellers *C* and *F* are found to be 0.028 and 0.030, respectively, in Table 1, and are recorded in the selection table in Fig. 8. Each impeller has a tip diameter of 12 in. while impeller *C* has an axial depth of 3¾ in. and impeller *F* an axial depth of 3$\frac{31}{32}$ in.

As in the first example, all pertinent design factors should be weighed to determine which of the two possible impellers is preferable.

toward the free flow point.

**Step 5:** Impellers which are found to be possible selections in Step 4 must now be evaluated with respect to the physical requirements on space, impeller horsepower, cost, quietness and any additional design considerations almost always involved in an air-moving system. Because most of these factors are interdependent, it is good practice to consider them all together in Step 5. A table such as that used in Fig. 7 is useful in organizing data.

Impeller horsepower, corresponding to the required flow rate on either performance curves or tables, and outside dimensions of the space required are given in the manufacturers' catalogs along with performance data. When using standard housings, dimensions of the housing are more important than those of the impeller itself. Three major dimensions of standard housings are given in Fig. 7 for the centrifugal impellers given in Fig. 4. Relative cost refers to the total cost of the impeller unit—including the impeller itself, housing, motor, inlet and outlet, and other associated components. Quietness is a function of such factors as the impeller type, motor speed and housing construction. The relative degree of quietness among several impellers may often be roughly determined at this point in the selection process on the basis of the inherent characteristics of various components and from prior experience. Additional design considerations may include desired sales features, weight, orientation and accessibility.

If no standard impellers pass Step 5, the original performance or physical requirements must then be changed in a way that is permitted in the application, yet allows the selection of a standard impeller. Steps 1 to 5 are then repeated until the optimum impeller is pinpointed. If there can be no compromise in performance and physical requirements, design of a special impeller may be necessary.

Illustration of the use of the performance-curve method of impeller selection is given in Example 1.

### *How to select impellers from*

## Tabular Data

First two steps in the selection procedure using performance tables are the same as Steps 1 and 2 in the performance-curve method. After the possible impeller types have thus been determined, required $Q_1$ and $p_{s1}$ are converted in Step 3 to values of $Q_2$ and $p_{s2}$ corresponding to a chart speed $n_2$ for which tabular data are given; e.g. Table 1.

**Step 4:** If $p_{s2}$ calculated in Step 3 does not exactly correspond to a table value, observe flow rates at the next higher and lower tabulated pressures. Linear interpolation between these values then gives the flow rate which the impeller delivers at $p_{s2}$. Most performance curves are linear in the operating ranges covered by such tabular data. Therefore, linear interpolation between adjacent columns is satisfactory for converting both flow rate and horsepower.

**Step 5:** Determine those impellers which produce approximately the flow rate $Q_2$ in the static-pressure column selected. In Table 1, for example, speeds are listed vertically along the left-hand margin, and eight values of static pressure are listed horizontally at the top from 0 to 0.375 in. of water. Flow rate and impeller horsepower are given for each speed and static pressure, as determined in standard NAFM pressure tests. The right-hand columns give flow rate and impeller horsepower for the same impellers in the NEMA free-air test.

Note that the flow rate achieved for any impeller in the NEMA free-air test is always substantially larger than the flow rates for the NAFM code test at zero static pressure. Although static pressures are zero in both tests, the test conditions are entirely different. The designer should be careful to use the free-air performance data only for impellers to be used under free-air conditions (unimpeded recirculation).

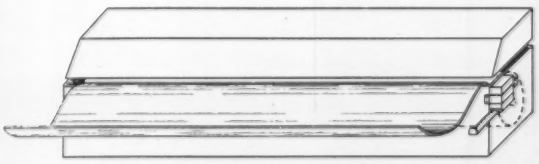
**Step 6:** The impellers which have been found to be possible selections in the performance tables must now be evaluated with respect to other physical and design requirements exactly as in Step 5 in the performance-curve method. Again a table like that in Fig. 7 may be helpful in organizing the data.

Illustration of the tabular-data method of impeller selection is given in Example 2.

# Tips and Techniques

### Measuring Drawing Paper

A steel tape measure attached to the box or holder of drawing paper rolls provides a quick method for obtaining the correct paper length. Both tape and paper are grasped and unwound simultaneously to provide a constant indication of the length of paper withdrawn. — H. M. CAMERON, *Armour Research Foundation, Chicago, Ill.*



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DESIGNING ELECTRONIC EQUIPMENT FOR MAINTAINABILITY *(Eighth of a Series)*

**Properly designed displays serve an important function in maintenance of electronic equipment. Practical suggestions for designing displays and methods of correlating displays with their associated controls are given in this article.**

# *Factors to consider in*

DISPLAYS on electronic equipment tell the technician whether the total system and its various units are operating within tolerance. If adequate displays are not provided, the technician's tasks of checking, adjusting and trouble shooting the system can often be quite difficult. Displays provided for the operator can be used for maintenance along with those built in only for the maintenance technician. Most of the principles that apply to the design of operator displays also apply to the design of special maintenance displays.* Only those design considerations that are especially pertinent to maintainability are presented in this article.

**Types of Displays:** All-or-none types of displays should be used where they will convey sufficient information. Use an indicator light if it will do the job, instead of a meter.

Use loud auditory signals to supplement indicator lights for displays that are not watched constantly when it is important that changes in their indication be noted immediately. For example, personnel on maintenance duty usually do not immediately notice a signal light come on when the high-voltage overload relay kicks out in routine operation on certain ground equipment. An audible signal, such as a horn or bell, would demand the immediate attention of maintenance personnel on duty.

Use moving-pointer, fixed-scale visual indicators for most maintenance indications. This is the best all-around type of indicator for checking, setting, tracking, and quantitative reading tasks.

Where center null displays are used, circuit design should be such that if power fails the indicator will not rest in the in-tolerance position.

**Display Movement:** The value of a particular function should increase as a pointer moves clockwise past a fixed scale or as a moving scale moves counterclockwise past a fixed pointer.

**Display Location:** Displays should be located so they can be read with minimum time and error in the normal course of maintenance activity. Ideally all displays should be on a single panel of the equipment. When practical considerations prevent this, the locations of displays should be determined by studying the maintenance procedures and hardware configuration. These will tell when a display is needed and where the technician will be at that time.

*Units with an Operator Panel:* Locate maintenance displays behind an access door on the operator's panel. The displays should be placed on the operator's panel because it will be accessible.

*C. A. Baker and W. F. Grether—"Visual Presentation of Information." *WADC Technical Report Number* 54-160, August, 1954.

Fig. 1 — Recommended control-display where more than one in-tolerance reading is to be measured. Control positions are color coded with display in-tolerance ranges.

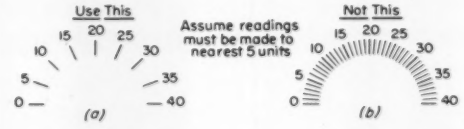


Fig. 2—Scales should only be fine enough to meet required reading accuracy.

By John D. Folley Jr. and James W. Altman
*Research Scientists*
*American Institute for Research*
*Pittsburgh*

# *designing* DISPLAYS

They should be covered so as not to confuse the operator.

*Units without Operator Panel:* Locate maintenance displays on one face of the equipment which will be accessible in a normal installation.

*All Units:* Locate displays so that they can be observed without disassembly or removal of any portion in the installation.

Displays used in system checking should be located so they can all be observed from one position. This may involve tilting displays situated in low or high places.

**Display Scale Markings:** Display scales should contain only information needed by the technician to make a decision or take some action. Extra data only clutter the picture. For example, a meter with a green strip to show the in-tolerance reading is preferable to one on which the mechanic must read the actual value—if the exact value is not needed.

Display scales should show the correct reading and the tolerance for the reading. A single center-scale colored area for in-tolerance is best. If more than one reading must be obtained from a single display, colored areas correlated with colored control settings can indicate the in-tolerance ranges, as shown in Fig. 1. Use of colors requires good display illumination.

Fig. 3—Display that provides both numerical information and in or out-of-tolerance indications.

Fineness of scale is another factor to evaluate. Display scales should have only enough graduations for the required accuracy to be obtained without interpolation, Fig. 2*a*. Scales that are too fine are usually only confusing, Fig. 2*b*.

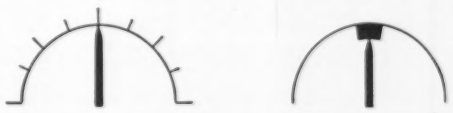

Fig. 4—Use a display with a numerical scale if actual values are needed. If only a tolerance range is required, use a scale with only an in-tolerance mark.

| | Use This | Not This |
|---|---|---|
| 1. | Transmitter Output | Power |
| 2. | + 300 V Supply | Voltage |
| 3. | Magnetron Current | Milliamps |

Fig. 5—Labels should indicate display functions.

| | Use This | Not This |
|---|---|---|
| 1. | NS Rate Servo Output | Rn |
| 2. | Turret Drive Motor Voltage | 115 VAC |
| 3. | TAS Transmitter Output | Rt |

Fig. 6—Labels should spell out where displays fit into the system circuitry.

Remember, however, that calibration may be useful for recording readings from periodic checks to discover deteriorating conditions as well as to make a decision from a single check at a particular time.

If a display must provide numerical information for some operations and only an in-tolerance or out-of-tolerance indications for others, both types of display markings should be used, Fig. 3.

Use a numerical scale only when the technician actually needs quantitative information; otherwise use areas marked with tolerance ranges, as depicted in Fig. 4.

**Labeling of Displays:** Labels should tell what functional quantity the display indicates rather than what electrical characteristic is indicated, Fig. 5.

Labels should tell where the displays fit into the block diagram of the system or unit, Fig. 6.

Display labels and control labels should be collated so that the display label suggests which control(s) affect the display, Fig. 7.

**Brightness of Displays:** Internal displays should be lighted where necessary. Internal areas of equipment are frequently almost "blacked out" by surrounding portions of the system or other equipment nearby. Displays which must be located in such areas should be lighted so they can be read by the technician. The nature of the installation must be considered when making these decisions, rather than the components taken individually.

| Use This | | Not This | |
|---|---|---|---|
| Control | Display | Control | Display |
| Transmitter | Transmitter | Power Adjust | Db Out |
| Output Adjust | Output | | |

Fig. 7 — A display label should suggest which control(s) affect that display.

| Control | Display |
|---|---|
| Clockwise | Clockwise<br>Right<br>Up |
| Forward | Clockwise<br>Right<br>Up |
| Up | Up<br>Clockwise<br>Right |
| Right | Right<br>Clockwise<br>Up |

Fig. 8—Direction of display movement, in order of preference, for four basic directions of control movement. The control movements are for function increases.

**Control-Display Relationships:** The relationship between control and display can affect the speed of control settings, errors made during setting, and accuracy of the final setting.

Relative locations of controls and displays is a primary consideration. Basically, each display should be mounted directly above the control affecting it. Of course, each display should be positioned to permit the required degree of reading accuracy by the technician operating the controls affecting that display.

All controls and displays used in a given procedure should be located on the same panel.

Control-display ratio is the amount of display change for given control change. Therefore, if fine adjustments are required, a large movement of the control should yield a small movement of the display. Conversely, if a wide range of display movement is required, a small movement of the control should yield a large display movement.

Where a wide range of display movement may be required but the end setting must be precise, one of the following alternatives may be used. A crank may be provided on a round control to facilitate rapid turning. The ratio of control-display movement may be kept at a medium value. Both a coarse and a fine setting control might be provided for a single display. Coaxial mounting will probably be most convenient.

As shown in Fig. 8, the direction of display movement should correspond to the direction of movement of its related control.

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This article is the eighth in a co-ordinated series by John D. Folley Jr. and James W. Altman. Previous articles and issues of MACHINE DESIGN in which they appeared are:

Designing Electronic Equipment for Maintainability ..... June 14, 1956
Units, Assemblies and Subassemblies .. June 28, 1956
Covers and Cases ..... July 12, 1956
Wiring, Cables and Connectors ..... July 26, 1956
Maintenance Accesses ..... Aug. 9, 1956
Test Points ..... Sept. 6, 1956
Controls ..... Sept. 20, 1956

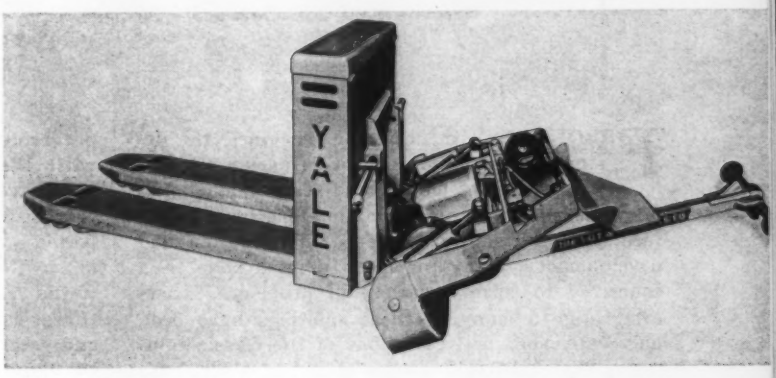
## Preventing Smudges

When large areas of a drawing such as fillet weld areas must be filled-in, an ordinary pencil will cause smudging. If a yellow, colored pencil is used there will be no smudging and the area will still be filled-in on any prints made.—H. M. CAMERON, *Armour Research Foundation, Chicago, Ill.*

# Contemporary Design

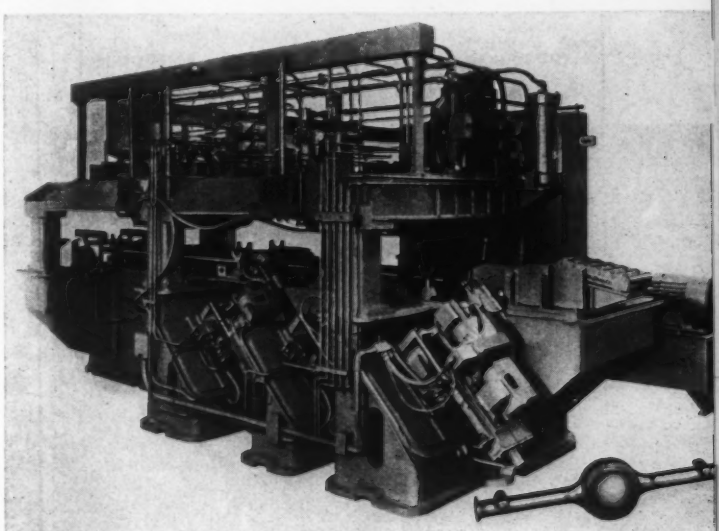
## Pallet Truck Swings Open for Easy Maintenance

REMOVAL of two pins, one on each side of the truck, permits the entire front end of a new pallet truck to be swung away from the battery compartment for inspection or maintenance. All hydraulic and mechanical units are immediately accessible. Available in 4000 and 6000-lb models, the new Yale & Towne Mfg. Co. Worksaver may be ridden or led by the operator. The trucks are only 24 in. longer than the load.




## Automatic Machine Pierces Housing, Installs Plug

ALL operations from piercing a hole to installing a threaded plug are performed automatically by a recently announced special machine. Labelled Line-O-Matic by its builders, LaSalle Tool Inc., the machine processes any one of three rear axle housings for passenger cars and trucks without modification. Parts are automatically loaded from a conveyor line and located. First operation is application of drawing compound and hydraulic piercing and extrusion of the drain hole. Next the drain hole is tapped for a ⅜-in. pipe plug and vent hole is tapped for a ¼-in. pipe plug. Sealing compound is then applied to the threads. Next a ⅜-in. pipe plug is automatically installed and tightened to 30 lb-ft torque. Housing is then automatically returned to a conveyor line.



A PAPER FROM THE

THIRD CONFERENCE ON MECHANISMS

# *Designing for intermittent motion with*

By Karl E. Kist, *Design Analyst*
*Harris-Seybold Co., Cleveland*

FREQUENTLY in designing machines, the designer is required to provide cycles containing periods of motion and rest, or standstill. Mechanisms for intermittent motions have therefore been the subject of much investigation and development. Many ingenious devices have been conceived to solve a variety of problems. However, a good many of these solutions have been only extensions and variations of the classic solutions. The modified starwheel is just such a mechanism. Its evolution and design are discussed here.

**Evolution:** Probably the simplest and most widely used means of accomplishing intermittent motion is the pawl and ratchet mechanism. However, as Lichtwitz[1] pointed out, the main disadvantage of the pawl and ratchet is that the components are not positively connected. This creates a problem when the pawl hits the wheel abruptly. Also, if the driven shaft is not braked sufficiently, the ratchet wheel will run ahead of the pawl during the period of deceleration or retardation. Satisfactory kinematic properties may be obtained, especially if the motion of the pawl is derived from cams. However, the lack of control during deceleration and standstill periods necessitate the use of auxiliary mechanisms such as brakes and locks.

Another of the classic mechanisms is the Geneva. Probably the main advantage of the Geneva is that the driven member is at all times under positive control. However, the distribution of motion and

[1]References are tabulated at end of article.

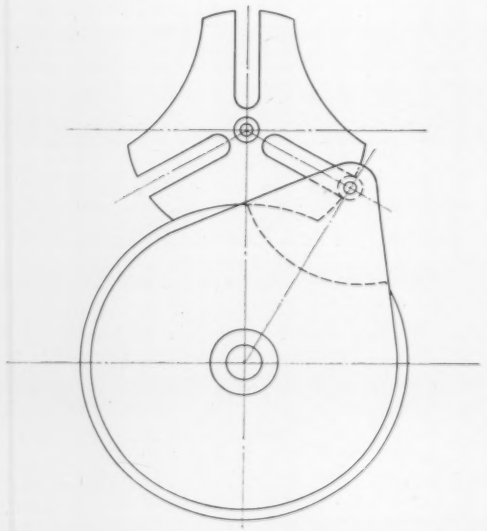


Fig. 1—Three-station Geneva, a cousin of the starwheel.

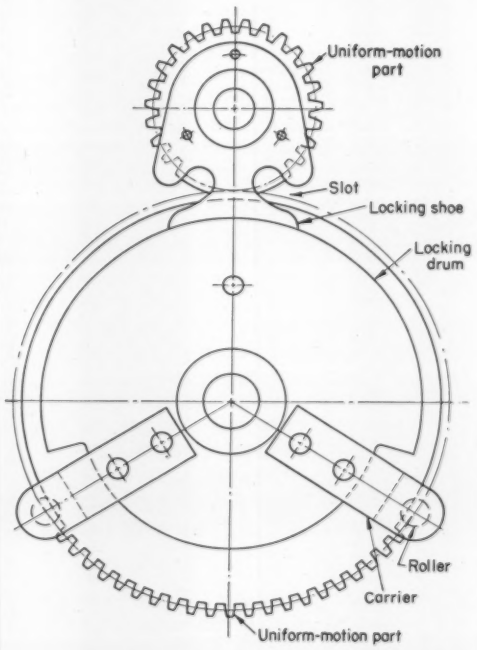



Fig. 2—Classical starwheel which permits full revolutions of driven members with intermediate standstills.

# MODIFIED STARWHEELS

standstill periods is not very flexible. Also, the number of stations or slots in the driven member can never be less than three, Fig. 1, or the partial movement of the driven shaft cannot exceed 1/3 revolution except in a few special cases. To overcome this limitation on motion, a kindred mechanism and a close relative to the Geneva, the starwheel, was developed.

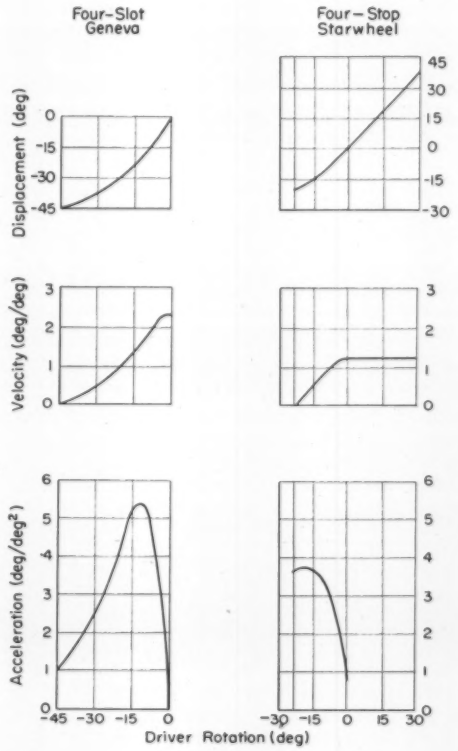


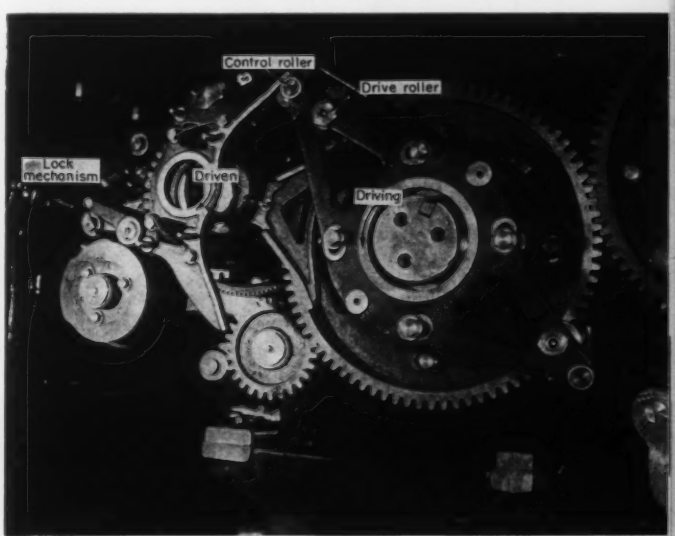

Fig. 3—Displacement, velocity and acceleration characteristics of a four-station Geneva and a basic starwheel.

The starwheel differs from the Geneva in that the distribution of motion and standstill periods can be chosen almost arbitrarily. With the starwheel, is it possible to impart full revolutions of driven members with intermediate standstills, a frequent requirement in machines. Such a device is shown in Fig. 2.

However, even though the Geneva and the starwheel can be used to produce many useful motions, it should be noted that both mechanisms have rather unfavorable kinematic properties.

Fig. 3 illustrates displacement, velocity, and acceleration diagrams for a four-slot Geneva and also the basic starwheel of Fig. 2. Both mechanisms have finite accelerations at the start of motion and consequently have infinite "jerk" (rate of change of acceleration). This, of course, means that a very large force is applied instantaneously as the cam roller contacts the cam slot. This force can cause shock and set up vibrations which may cause failure, excessive wear, or in the case

Fig. 4—Unidirectional stopping design for an offset lithographic printing press.



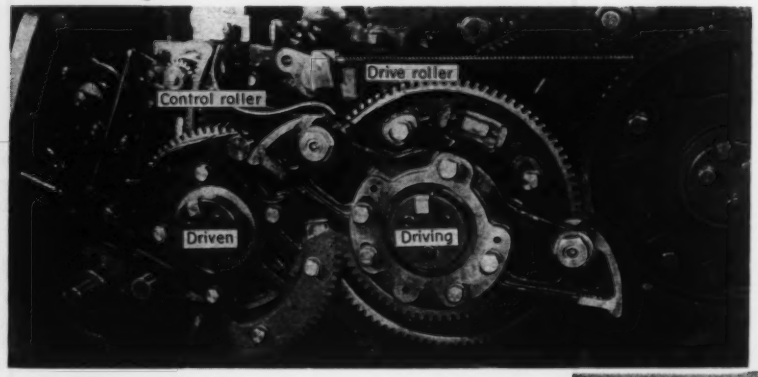
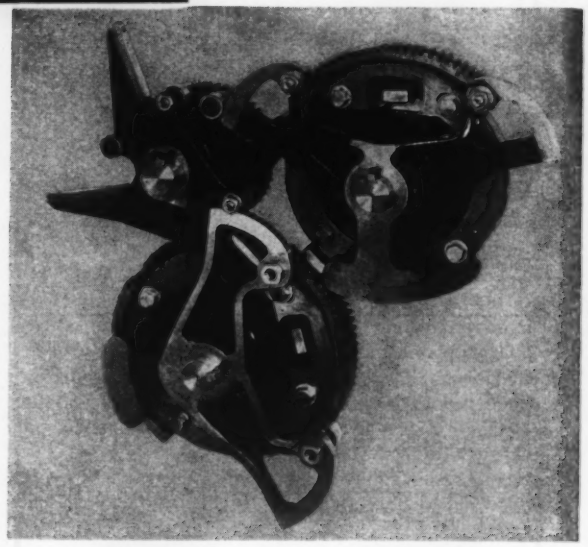



Fig. 5—Left — Unidirectional nonstopping design for alternately slowing and speeding a cylinder on a printing press.

Fig. 6—Below—Bidirectional arrangement for reciprocating a feed carriage on a metal-decorating press.



of a multicolor printing press, misregister of the print (misplacement of one color with respect to another).

The use of a closed slot as the cam surface for the nonuniform motion is the feature which limits these mechanisms and dictates the kinematics. In the case of the starwheel, the slot must take the path of an epicycloid to allow the roller to exit after the geared portion of the mechanism has assumed control. This same slot is then employed as the accelerating cam of the mechanism and hence controls the kinematics of the nonuniform run. In other words, the geometry of motion is the controlling factor.

The problems presented by closed slots have been solved by separating the sides of the slot into two cam surfaces in different planes of action and using two rollers, one for driving and one for controlling. The addition of this single consideration made available a whole class of mechanisms which have many of the advantages of the basic starwheel, but few of the disadvantages. These mechanisms we call modified starwheels.

**Motion Patterns and Applications:** The modified starwheel is even more flexible than the basic starwheel with respect to motion patterns and has been employed to produce the following motions:

1. Unidirectional stopping—the most common type used to produce rotation in one direction with one or more standstill periods.
2. Unidirectional nonstopping—used to produce a controlled shift between two uniform speeds.
3. Bidirectional—used to provide controlled reciprocating motions.
4. Combinations—to provide both stopping and controlled shift between two uniform motion cycles.

The mechanism shown in Fig. 4 is used for a unidirectional stopping cylinder application on an offset lithographic printing press. In this design both the drive and control shoes are mounted on the driven member and both sets of rollers (drive and control) are mounted on the driving member. However, this is an early design and does not represent the preferred arrangement of components.

This design also incorporated an auxiliary locking mechanism. To provide better locking control, a cam-driven locking pawl which engages a slot on the driven member is employed rather than the conventional drum used on the Geneva.

Fig. 5 shows a unidirectional nonstopping application used to alternately slow down and speed up a cylinder on a printing press.[2] This design illustrates the preferred method of locating the control shoes on the driving member and the control rollers on the driven member. This arrangement allows a more compact design in the axial direction, thus reducing overhang and allowing stiffer construction.

Fig. 6 shows a bidirectional design used to drive a reciprocating feed carriage weighing 160 pounds on a metal-decorating offset lithographic press.[3] Two identical drivers rotate at 100 rpm in opposite directions and alternately drive the driven member.

The mechanism shown in Fig. 7 is used to drive a shaft to produce a controlled acceleration, a uniform motion, a shift to a slower uniform motion, a deceleration and a standstill period. The use of the control shoe on the driver to produce positive control of the standstill period is illustrated in this design. Excellent control of standstill periods is effected here because the same rollers that are used to control during acceleration and deceleration are used as locking rollers.

**Design Considerations:** The preferred arrangement of components for the modified design uses three planes of action: one for uniform-motion components, one for driving shoes and one for control shoes. Driving rollers are then mounted on control cams and control rollers on the driven shoe. Rollers are mounted on the pitch lines of the gears, and cam surfaces are selected so that the line of pressure between the roller and cam is tangent to the gear pitch lines at the transition to uniform motion and, in the case of the full-stop design, perpendicular to the gear pitch lines at the transition to standstill.

Reference to Fig. 8, the geometry of the control cam,[4] illustrates that any cam profile which serves the end or transition conditions may be used. Therefore, the designer can give attention not only to the motion desired, but also to the velocities, acceleration and if conditions warrant, the rate of change of acceleration or "jerk." Whether this is warranted will depend, of course, upon the particular application, the speeds desired, and the consequent loads.

There has been much attention given to cam profiles lately and, without lengthly discussion, it should be sufficient to say that any of the various paths may be used.[5]

The components for imparting uniform motion are selected according to the requirements for ordinary involute gears. Usually all the teeth are cut on both gears and then one is cleared of teeth in the portion where the cam surfaces have control of the mechanism. Or, if there is a large period of standstill or two uniform-motion portions using gears of different pitch diameters, segments of gears may be used for economy.

The transfer of control from the cam surfaces to gearing must be given close attention to insure that it occurs accurately and smoothly. This may be accomplished by designing the cams so that the driven member has been accelerated to the velocity of the uniform run before gear-tooth contact.

Another method is to determine the angle of approach[6] of the gears used to impart the uniform motion, and then to clear the driving sector of teeth so that the angle between the center of the driving roller and the tip of the first involute tooth

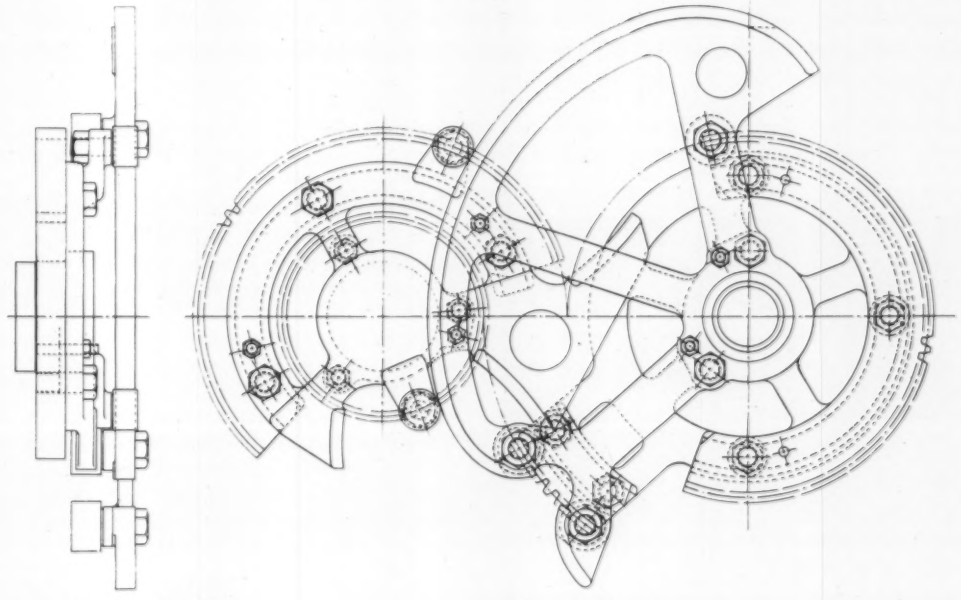


Fig. 7—Above—Combination design for producing six sequential actions: controlled acceleration, uniform motion, deceleration, uniform motion, deceleration, and standstill.

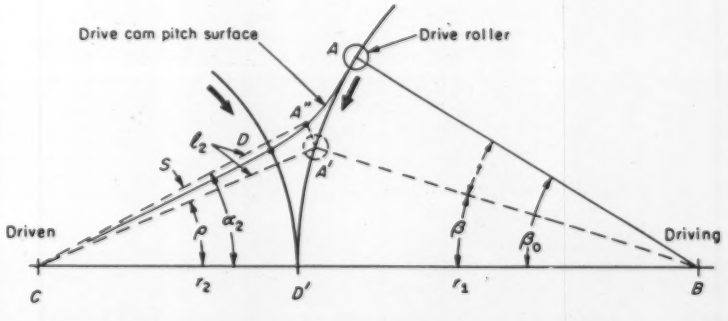



Fig. 8—Right—Geometry of a control cam.

is equal to or greater than the approach angle.

The transfer of control from standstill or locked position to the accelerating cam is also very important. A short dwell at the contact point between cam and driving roller, so that the roller may be eased into the cam while the locking parts still have control, facilitates a smooth transfer and aids in setting the mechanism.

**Limitations:** It should be noted that the modified starwheel has several limitations which the designer should keep in mind.

When selecting the period allowable for cam motion, clearance between cams and rollers during uniform-motion periods must be checked thoroughly. Selection of too large an accelerating or decelerating period may result in interferences in other parts of the cycle. Our experience at Harris-Seybold has been that 30 to 40 degrees rotation of the driven member usually gives good results.

Also, the number of stations or standstill periods is limited by the increased time allotted to acceleration and deceleration during nonuniform motions.

**Materials, Dimensions and Tolerances:** Heat-treated engineering gray iron has proved to be a satisfactory material for cam shoes in our unidirectional designs, both stopping and nonstopping.

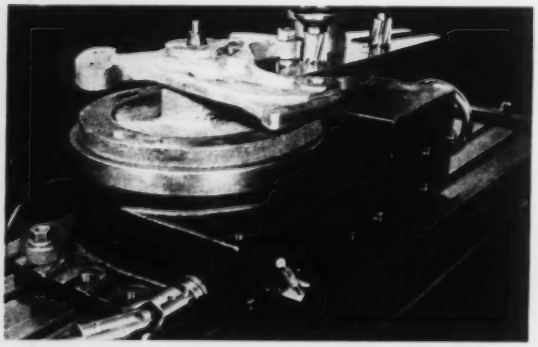
In a conventional design of this type there are only two shafts, four cam surfaces and four rollers to consider. These designs have been found to be only moderately sensitive to dimensional deviations. Cam profiles are held to a tolerance of $\pm$0.003-in. and the roller and shaft centers are held to $\pm$0.002-in.

In the first designs of this type, rollers with eccentric studs were used to provide for correction of any manufacturing errors, but this precaution proved unnecessary and was discontinued.

It was necessary, in the bidirectional design to use heat-treated steel for the cam shoes. Steel was used, of course, to gain the higher modulus of elasticity for deflection requirements. The cam surfaces are held to a total variation of 0.001-in. and the roller and shaft centers to $\pm$0.002-in., since this arrangement is quite sensitive to dimensional deviation. It will be noted from Fig. 6 that at the transition from deceleration to acceleration in either direction there are four rollers in contact with four cam shoes at the same instant. To facilitate setting the mechanism, it was necessary to mount each of the driving rollers on a double eccentric. This was accomplished by using an eccentric stud on the roller and an eccentric sleeve around the stud. Scribed lines indicate neutral or zero settings. Also, each of the control rollers has an eccentric stud. This is necessary to permit corrections to be made due to manufacturing tolerances and, also, to provide a means of compensating for deflections due to inertia loads.

Fig. 9—Above—Fixture for machining drive shoes on boring mill.

Fig. 10—Below—Fixture for generating complementary control shoe from drive shoe.



**Manufacturing Techniques:** We were unable to find any commercial cam-producing equipment which was capable of producing cams of the accuracy needed. Therefore, it was necessary to develop fixtures, adaptable to standard machine tools, to accomplish the desired results.

Fig. 9 shows such a fixture which was designed by our tool engineers to manufacture the four-cam modified starwheel shoe for the driven member of the reciprocating drive. The master cam is three times actual size so that a reduction in tolerance is effected on the actual part being machined. With this set-up, the cam contour is being held to a total variation of 0.001-in. This fixture is being used on a large horizontal boring mill.

Fig. 10 shows a similar fixture which is being used to generate the control shoe from the drive shoe. This insures that the cam surfaces are complementary to each other. Results from the use of these fixtures are very satisfactory.

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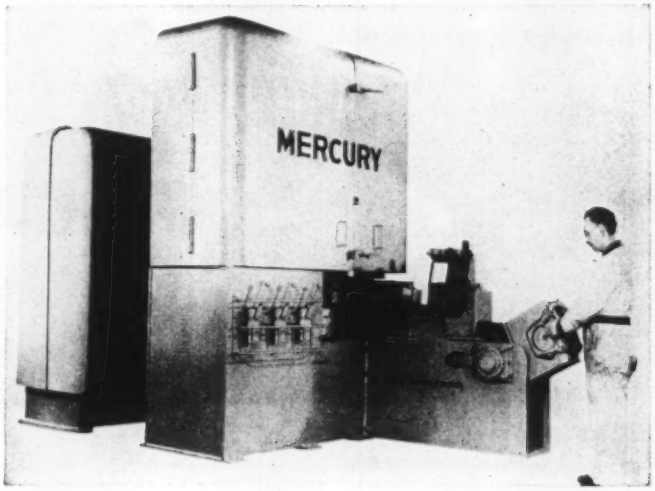
This article was presented as a paper at the Third Conference on Mechanisms. Purdue University, May 24-25, 1956. The Conference is cosponsored annually by the Purdue School of Mechanical Engineering and MACHINE DESIGN.

# Snag Grinding Machine—

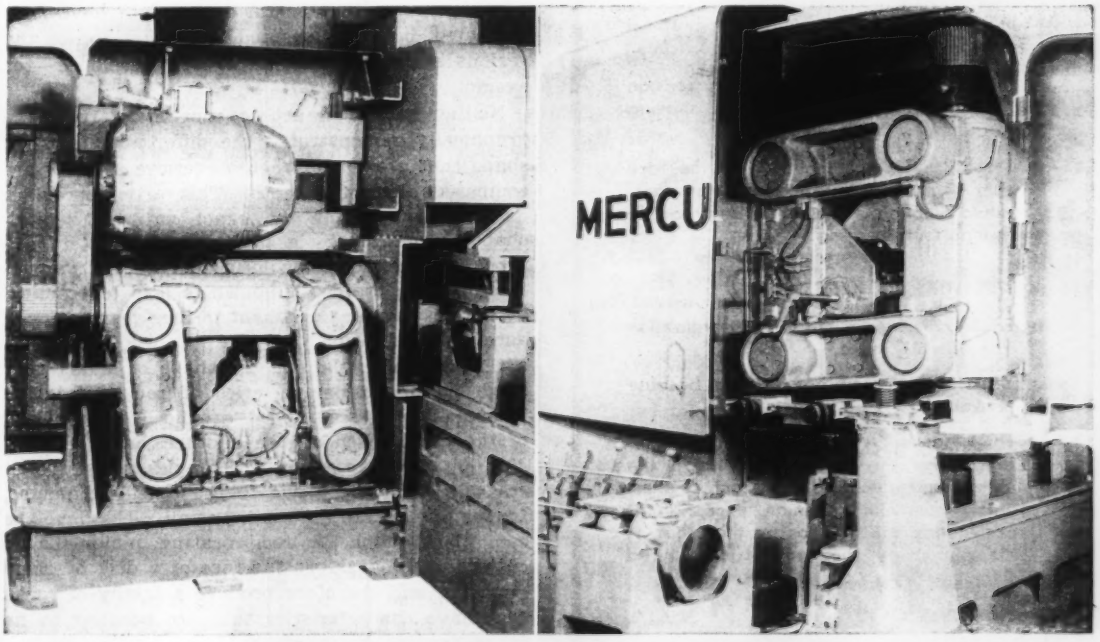
## Timing Belt Drives Eliminate Ways




THIS recently introduced conveyorized snag grinder faces front, rear and top of 6000 automotive transmission cases daily. Cast cases are placed in a holding fixture for their trip through the machine and removed from the fixture at the discharge end. The three grinding operations are performed automatically. A product of Mercury Engineering Corp., the machine incorporates three unique grinding wheel feed devices utilizing U. S. Rubber Co. timing belt drives.

**Parallel rocker-arm suspension** of two horizontal and one vertical grinding spindle eliminates the use of machined ways and provides a 4-in. feed range. Very smooth motion results from the use of preloaded tapered roller bearings at the rocker joints. Relative motion between the 40-hp drive motor and the grinding spindle is permitted by the elongated driven pulley. This method permits the drive motor to be permanently mounted on the machine so that its weight is not added to that of the grinding spindle, and this system is also relatively inexpensive. Since the PowerGrip timing belt is toothed, high belt tension is not necessary for power transmission. This allows the belt to slide axially on the pulley as the spindle is fed to or away from the workpiece by a cylinder.

Driving pulley is 4.38 in. wide with pitch diameter of 4.77 in. Driven pulley is 10 in. wide and has 7.63 in. pitch diameter. The belt is 4 in. wide. Driven pulley speed is 1100 rpm.




**CONTEMPORARY DESIGN**



XUM

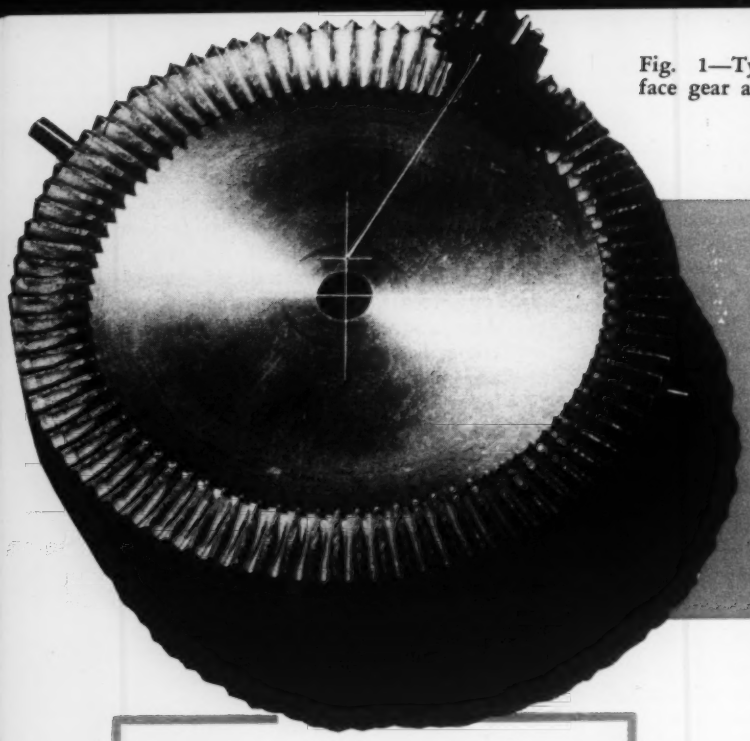


Fig. 1—Typical on-center face gear and pinion.

# *Unique graphical*

# FACE-

### *Advantages of Face Gears*

- The pinion—whether spur or helical—can be displaced across the gear face without disturbing conjugate action.
- Backlash introduced when the pinion is withdrawn from intimate contact with the mating gear (up to 10 per cent of working depth) is not disturbing for most reduction ratios.
- The pinion can be cut and shaved on standard gear generating and shaving machines.
- Eccentricity in the mounting of the face gear, while affecting uniformity of transmitted motion, does not appreciably change tooth bearing.

### *Limitations of Face Gears*

- Face gears are limited to the transmission of moderate loads.
- Very low ratios are not practical because of limited face widths.
- For best results, particularly in the low-ratio range, the generating cutter for the face gear should be an exact counterpart of the mating pinion, except in its addendum, which is longer than that of the pinion by the amount of desired clearance.

DESIGN techniques for on-center and nonintersecting face gears have been described in a number of articles and books that have appeared during the past few years.[1-3] Charts and formulas giving optimum inside and outside diameters and other useful design data have been presented, both in the cited references and in the various standards that have been developed—for example, AGMA 203.01.

Neither published articles nor standards have graphically demonstrated the differences in tooth shape that are found when successive sections are compared along the tooth. This article provides graphic evidence of the exact nature of tooth shapes generated by a pinion-shaped cutter reciprocating across the face of a gear disk. Examination of these profiles is shown to lead to practical design observations pertinent to face-gear performance and application.

One way of explaining the shape of a face-gear tooth is to consider a series of racks of infinitesimal thickness wrapped around a disk. Each of the racks, piled one on another, has a slightly different pressure angle, with angles gradually increasing from the inside to the outside diameter. Linear pitches are different, but all racks have the same base pitch. A reciprocating pinion-shaped cutter, stroking across the face of a disk of given diameter, will therefore produce a family of racks that have characteristics that are peculiar to no other family. Each of the individual racks has

[1]References are tabulated at end of article.

*study demonstrates fundamentals of*

# GEAR GEOMETRY

By Louis D. Martin
Gear Consultant, Rochester, N. Y.

the same base pitch as the reciprocating cutter used to generate it.

## Finding Tooth Profiles

An on-center face gear of 32 diametral pitch is shown in Fig. 1. It was generated with a reciprocating cutter having a pressure angle of 20 degrees and meshes a pinion of the same size and number of teeth as the generating cutter. An offset face gear and pinion are shown in Fig. 2. In this example, the pinion axis is offset 0.250-in.

These gears were fabricated by winding 77 layers of bronze shim stock, 0.003-in. thick, on a brass core. To retain the bronze stock tightly on the center core, a brass ring was shrunk over the several layers of shim stock. Two dowels were inserted through the layers of shim stock, as shown, as a precaution against slippage. It can be readily seen that the top lands of the teeth of the on-center face gear (Fig. 1) are considerably different from those of the offset face gear (Fig. 2). It is also apparent that the offset face gear has less usable face width on one tooth flank than on the other. The ratio between these gears and mating pinions is 3.636:1. This ratio was chosen because it is within a very practical range and the gear-shaper cutter has ample rigidity.

Two other examples of offset and on-center face gears and pinions are given in Figs. 3 and 4. These blanks were also constructed by winding successive layers of bronze shim stock on a central core and

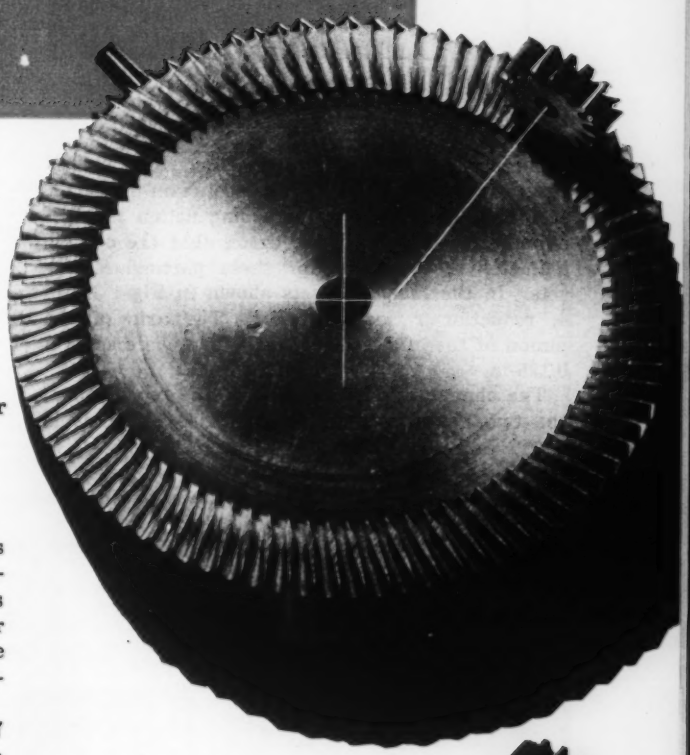


Fig. 2—Above—Typical offset (eccentric or nonintersecting) face gear and pinion.

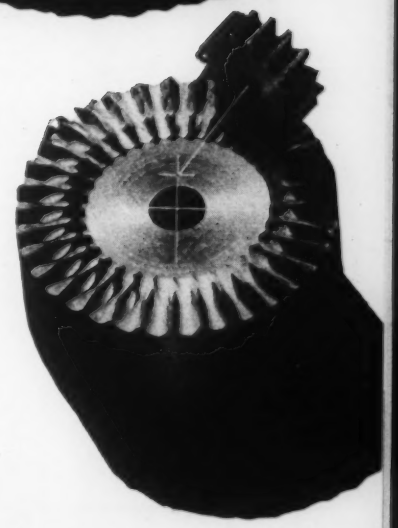


Fig. 3 — Right — On-center face gear with 1.5:1 ratio.



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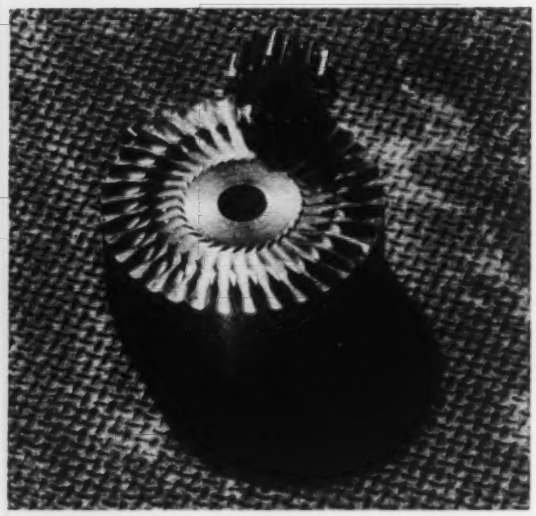


Fig. 4—Offset face gear with 1.5:1 ratio

retaining them tightly with a shrink ring. In this case, 62 layers of stock were piled one on the other. It will be seen from the trimming action that resulted from the generating cutter that the outside diameter is too great for these particular gear sets. In the face gear sets shown in Figs. 3 and 4, reduction ratios are 1.5:1. The axis of the pinion of the offset face gear (Fig. 4) is displaced 0.125-in.

The change in configuration of the top lands of the two gears is readily seen. Also apparent is the trimming action that occurs at the inside and outside of the usable tooth area at the points where the top land disappears. It will be noted that as the ratio becomes smaller, there is a considerably smaller usable tooth area. The outside and inside diameters of these gears were exaggerated deliberately for the purpose of illustration and in order to obtain a tight squeeze on the layers of shim stock.

An enlarged view of the top lands of the on-center face gear (Fig. 1) is shown in Fig. 5. Located on this diagram are four different sections—*AA, BB, CC,* and *DD*—taken at different points—on the tooth. These sections are selected points of a single tooth chosen for graphical examination. In order to do this, the shrink ring used to retain the shim stock was removed from the gear. The strip of thin stock was then unwrapped, one layer at a time, for identification (see fragmentary view). Since two dowels were inserted in the gear blank opposite each other, each convolution of shim stock could be identified by the dowel holes in the unwound strip. In this manner, corresponding tooth profiles and points of contact were identified and cross checked against their computed positions.

## Profiles for Favorable-Ratio Gears

Tooth profiles for the on-center face gear (Fig. 1) are graphically compared in Fig. 6. Examination of these sections reveals the following characteristics:

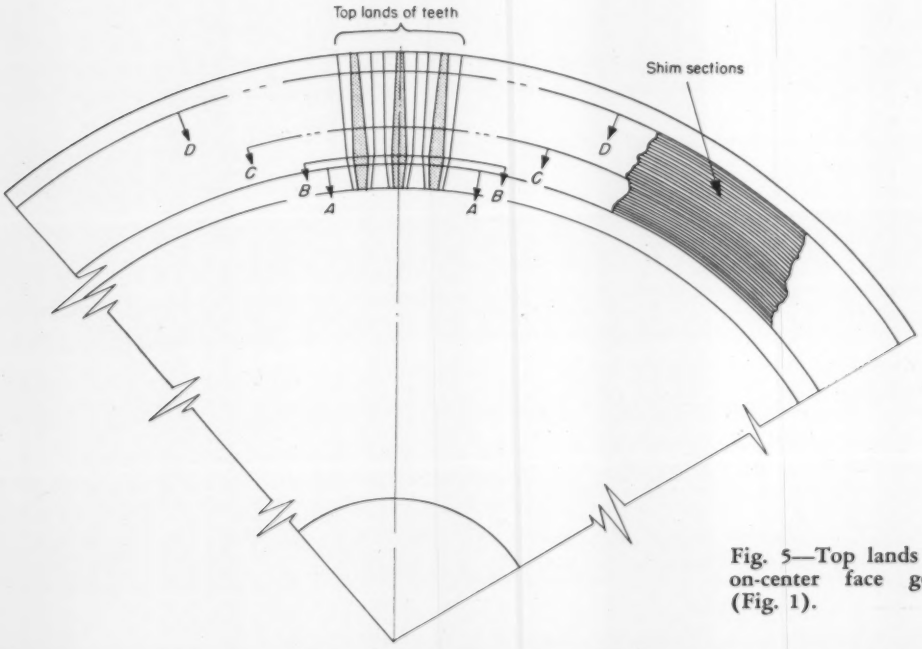



Fig. 5—Top lands of on-center face gear (Fig. 1).

*Section AA:* Area of complete undercut; shows high trochoidal curve with complete loss of usable profile. This is the result of too great a reduction in circular pitch.

*Section BB:* Boundary point where complete loss of profile begins. Approximately 80 per cent of the tooth profile is cut away.

*Section CC:* Shape at the standard pitch line where the diameter is equal to the number of teeth divided by the diametral pitch. Tooth shape at this point is identical with the shape of the conjugate 20-deg pressure angle rack. Comparison of the generated tooth shape at 62½ times size checked exactly with the pressure angle of the generating cutter.

*Section DD:* Shape at the outside diameter. The pressure angle is considerably greater at this point, having increased from 20 deg to 31½ deg. This diagram shows that an arbitrary choice of outside diameter gives a reasonably broad top land, which is good practice. Had the design been critical for load transmission, it would have been possible to have increased the face width to the point where the circular pitch becomes so large as to give zero land width. Suitable top land is obtained by chamfering the teeth, giving a slight taper of the addendum and a negligible loss in contact. This expedient is used when ratios are critical, and where every means possible must be used to obtain satisfactory face width.

Four sections taken through the offset face gear (Fig. 2) are shown in Fig. 7. Sections chosen for observation are similar to those selected for the on-center gear; that is, they were taken at corresponding points of contact. Characteristics of these sections are:

*Section AA:* Area of complete undercut.

*Section BB:* Area of 80 per cent undercut.

*Section CC:* Taken at the standard pitch line; shows slight convexity on the coast side and slight concavity on the drive side. Departure from a

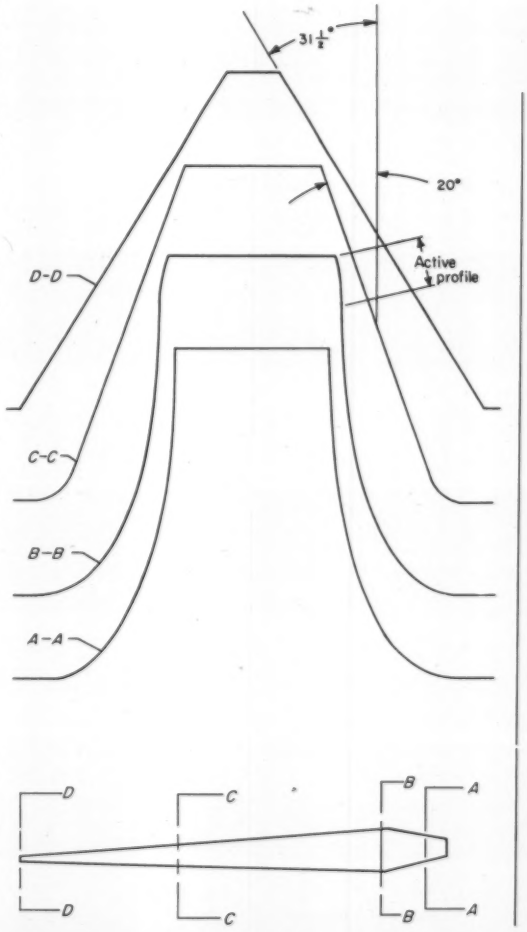
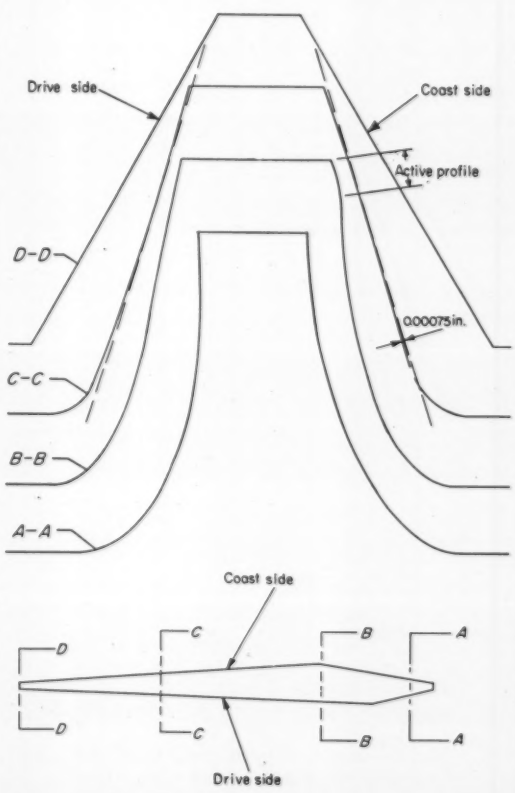



Fig. 6—Left—Tooth profiles taken at the sections shown for the on-center face gear in Fig. 5.

Fig. 7—Below—Tooth profiles of the offset face gear (Fig. 2).



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straight side for this particular ratio is approximately 0.00075-in.

*Section DD:* Section taken at the outside diameter; for all practical purposes, has straight symmetrical sides.

## Profiles for Critical-Ratio Gears

It should be recalled that the reduction ratio for the two gears just discussed is 3.636:1 and that the offset for the gear in Fig. 7 is 0.250-in. These are favorable values. Let us now examine the tooth forms resulting when critical values are chosen for ratio and offset.

Three sections taken from the on-center face gear (Fig. 3) are given in Fig. 8. In this series only three sections are presented because remaining sections have no particularly interesting features.

*Section AA:* Shows complete loss of tooth profile; compares with Section *AA* in Fig. 6.

*Section BB:* Taken through the pitch line which is identical to the conjugate rack. Exactly like Section *CC* in Fig. 6 because same cutter was used.

*Section CC:* Taken at the outside diameter. Note that the pressure angle has increased from 20 deg to 36 deg. This increase is greater than that shown in *DD* in Fig. 6 for two reasons: first, because a point having a relatively narrower top land was chosen for the outside diameter (compare with *DD* in Fig. 6) and, secondly, because the rate of change from inside diameter to outside diameter was greater for the smaller ratio of 1.5:1 used in Fig. 6. In other words, the relationship of circular-pitch change to pressure-angle change is considerably greater for this family of rack sections than it was for the family shown in Fig. 6.

How the choice of relatively small ratios and relatively large offsets affects tooth geometry is illustrated by consideration of the face-gear in Fig. 4. Ratio for this set is 1.5:1 and offset is 0.125-in., which is half the offset of the gear in Fig. 2. Sections are shown in Fig. 9.

*Section AA:* Shows a section of complete undercut occurring on the drive side. Note the difference between the coast and drive sides.

*Section BB:* Shows a marked lack of symmetry occurring on the coast side. The drive side is straight in this section, while the coast side has a double curve, as can be observed from the reference line.

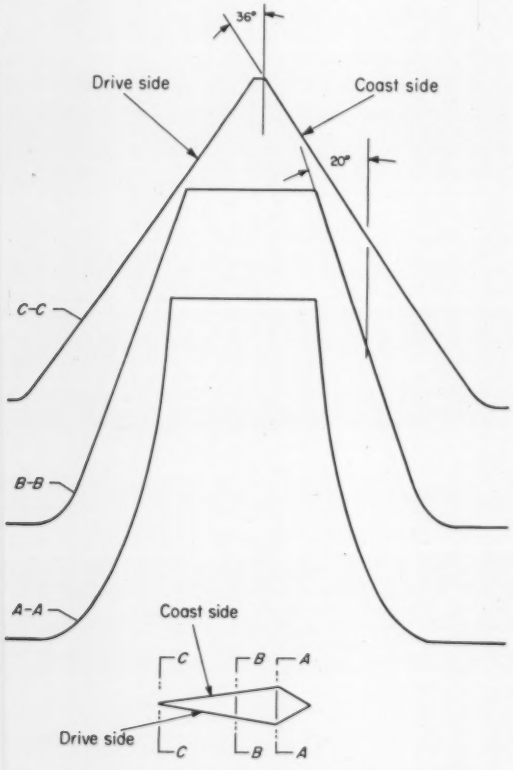



Fig. 8—Above—Tooth profiles of the on-center face gear with 1.5:1 ratio (Fig. 3).

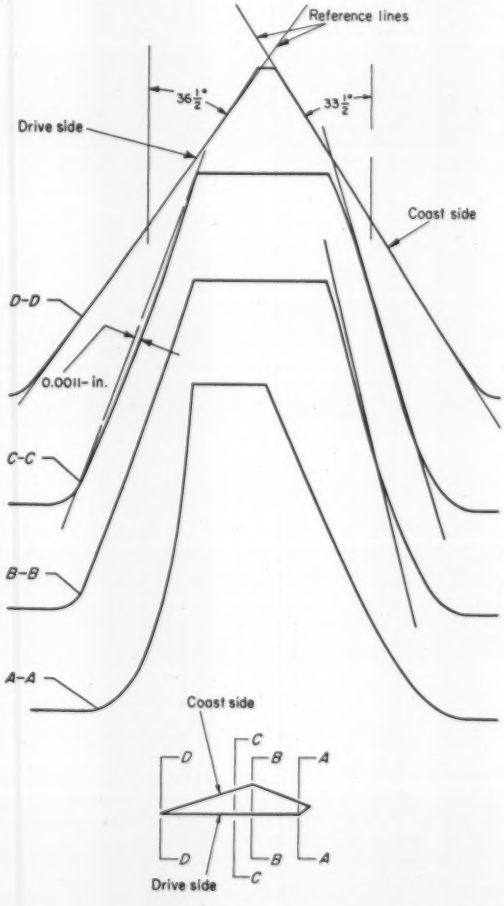



Fig. 9—Right—Tooth profiles of the offset face gear with 1.5:1 ratio (Fig. 4).

*Section CC:* The profile deviation from a straight line is very pronounced on this pitch-line section, as can be seen from the reference lines. The coast side has a double curve somewhat greater than at *BB,* while the drive side has a pronounced dip amounting to approximately 0.0011-in.

*Section DD:* Section at the outside diameter. For all practical purposes, the sides are straight, as can be seen from the reference lines. The pressure angle of this section, however, is not symmetrical, being 33½ deg on the coast side and 36½ deg on the drive side.

This pictorial analysis of face gear tooth shape must only be considered qualitatively. A quantitative analysis that would fit any possible combination of variables would become too complex due to the almost infinite number of variables.

The graphical demonstration shows that a particular section of an offset face gear cannot be considered as a straight-sided rack. This condition is only true for certain favorable ratios and offsets, as demonstrated, and at selected positions. Geometric computation sometimes err, and analytical diagrams cannot be considered as accurate as precise measurements taken of a cut gear under laboratory conditions.

## Effects of Cutter Size

The change that occurs in the rolling cone elements when a face gear is generated with a cutter larger than the mating pinion is shown in Fig. 10. It will be seen that the angle $\gamma$ formed by the rolling cone element of the cutter is larger than the angle $\gamma$ formed by the rolling cone of the pinion. This means that the family of rack sections generated by the cutter are different from those that are fully conjugate to the mating pinion. The circular-pitch relationship is also incorrect. The pitch produced by the cutter will be greater than that of the pinion. Greater trimming of the active profile at the inside and outside diameters will occur, and faulty tooth bearing will result. It is a matter of degree. With large diameters, high ratios, and relatively fine pitch, the cutter may be somewhat larger than the mating pinion without undue sacrifice in tooth bearing. But when the ratio is low and maximum load-carrying capacity is desired, the cutter should be a facsimile of the mating pinions in all respects, excepting the allowance made for clearance on its outside diameter.

## Practical Observations

From this graphic analysis, it is possible to draw the following conclusions:

1. Face gears generated with an involute cutter may be considered as consisting of families of racks of infinitesimal thickness having a common base pitch, but having a varying circular pitch and pressure angle.

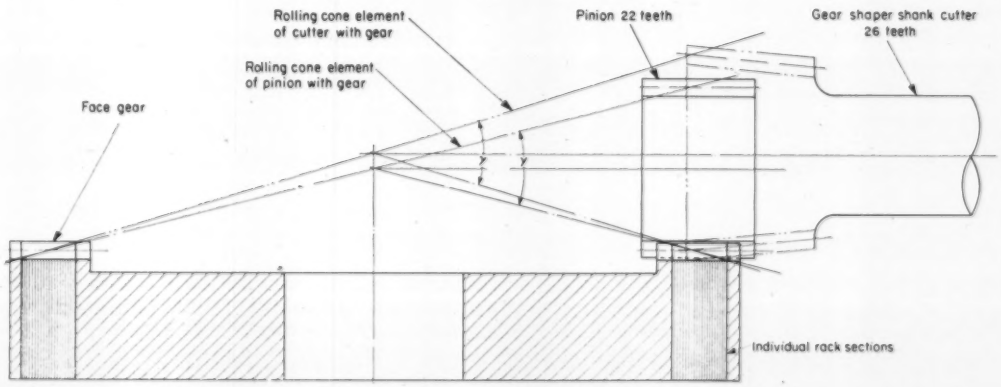
2. The family relationship between one gradient of pressure angle and circular pitch change is unique, and is typical of no other family.

3. A face gear generated with a reciprocating pinion-shaped cutter of a given number of teeth, pitch and pressure angle will be fully conjugate to a pinion having the same characteristics and size as the generating cutter.

4. The change in tooth bearing resulting from the use of a generating cutter larger than the mating pinion is greater and more detrimental in low ratios than in high ratios.

5. The tooth section at the standard pitch line of an on-center face gear, where the diameter is equal to the number of teeth divided by the diam-

Fig. 10—Change in rolling cone angle due to use of cutter larger than mating pinion.


Rolling cone element of cutter with gear
Pinion 22 teeth
Gear shaper shank cutter 26 teeth
Rolling cone element of pinion with gear
Face gear
Individual rack sections



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etral pitch, is identical with the basic rack of the particular tooth form system of which the cutter and pinion are members.

6. The shape of the rack tooth of infinitesimal thickness of an offset face gear is asymmetrical. Its lack of symmetry is dependent on the ratio and amount of offset.

7. The amount of usable face of an offset face gear is different on the coast side than on the drive side. It is affected by the amount of offset, ratio and pressure angle.

8. In order to obtain maximum tooth bearing, the rate of change in circular pitch and pressure angle in a sequence of contact points must be the same for the mating pinion as for the generating cutter.

The foregoing general conclusions can be drawn and inferred from this graphical presentation. It is hoped that this graphical analysis will lift the veil of mystery a little more from this useful type of gear.

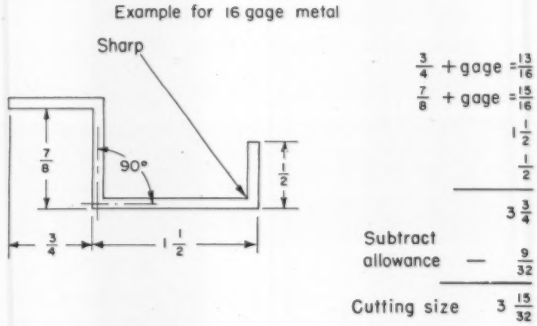

REFERENCES

1. B. Bloomfield—"Designing Face Gears," MACHINE DESIGN, Vol. 19, No. 4, April, 1947, Page 129.
2. *The Face Gear*, Fellows Gear Shaper Co., Springfield, Vt.
3. E. Buckingham—*Analytical Mechanics of Gears*, McGraw-Hill Book Co. Inc., N. Y., 1949.


# Tips and Techniques

## Bend Allowances

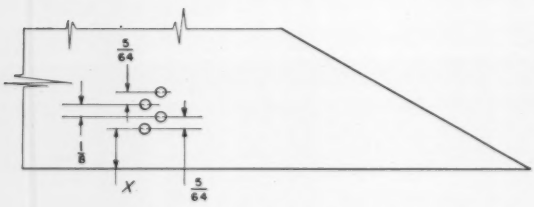
IN BENDING parts from sheet metal an allowance for the bends must be made when computing the total length of metal required for the part. The accompanying table gives amounts to be allowed for bending aluminum of 10 to 24 gage. Calculations for the sample shape demonstrate the application of the material in the table.—CAROL L. IAMS, *Bird Electronics Corp., Cleveland, O.*




| Metal Gage | Metal Thickness (in.) | Thickness for Calculation (in.) | Deduction for Number of Bends (in.) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 1/40 | 1/32 | 3/64 | 3/32 | 9/64 | 3/16 | 15/64 | 9/32 | 21/64 | 3/8 |
| 22 | 1/32 | 1/32 | 3/64 | 3/32 | 9/64 | 3/16 | 15/64 | 9/32 | 21/64 | 3/8 |
| 20 | 3/80 | 1/32 | 1/16 | 1/8 | 3/16 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 |
| 18 | 1/20 | 3/64 | 5/64 | 5/32 | 15/64 | 5/16 | 25/64 | 15/32 | 35/64 | 5/8 |
| 16 | 1/16 | 1/16 | 3/32 | 3/16 | 9/32 | 3/8 | 15/32 | 9/16 | 21/32 | 3/4 |
| 14 | 5/64 | 5/64 | 1/8 | 1/4 | 3/8 | 1/2 | 5/8 | 3/4 | 7/8 | 1 |
| 13 | 3/32 | 3/32 | 5/32 | 5/16 | 15/32 | 5/8 | 25/32 | 15/16 | 1 3/32 | 1 1/4 |
| 12 | 7/64 | 7/64 | 11/64 | 11/32 | 33/64 | 11/16 | 55/64 | 1 1/32 | 1 13/64 | 1 3/8 |
| 11 | 1/8 | 1/8 | 13/64 | 13/32 | 39/64 | 13/16 | 1 1/64 | 1 7/32 | 1 27/64 | 1 5/8 |
| 10 | 9/64 | 9/64 | 7/32 | 7/16 | 21/32 | 7/8 | 1 3/32 | 1 5/16 | 1 17/32 | 1 3/4 |

## Triangle Lettering Guide

A most-used triangle can also be a lettering guide. A series of holes drilled with a No. 58 or 59 drill, as shown, are used to quickly construct guide lines by placing a pencil point in the appropriate holes and sliding the triangle along the straight edge. Hole spacing as well as distance, *X*, from triangle edge to the first hole may be varied to suit the user.—D. J. COLOCCIA, *Wheeler Laboratories Inc., Great Neck, N. Y.*




## Drawing Symmetrical Objects

When using a French curve to draw objects which are symmetrical about centerlines, graduating the edge of the curve will simplify the job. Every fourth graduation should be slightly longer than the others and should be assigned a number or letter. The numbers or letters are not in themselves important since their only purpose is to identify a particular portion of the curve so that the same portion may be used to draw all symmetrical line segments.—D. W. BAUMBACH, *Lockheed Aircraft Corp., Van Nuys, Calif.*

Do you have a helpful tip or technique for our other readers? You'll receive ten dollars or more for each published contribution. Send a short description plus drawings, tables or photos to: Tips and Techniques Editor, MACHINE DESIGN, Penton Bldg., Cleveland 13, O.

*Nomographs aid calculation of*

# Pressure Losses in Hydraulic Lines

By E. H. Gatwood
*Circuit Group Supervisor*
*Vickers Inc.*
*Detroit*

PROPER and efficient hydraulic circuits depend to a great extent upon design for optimum pressure drops in the system. Extremely small pressure losses are not economical because of cost of large piping and valves. On the other hand, high pressure drops are accompanied by large energy losses and excessive heating.

This article presents a series of charts that solve the mathematical relationships involved in computation of pressure drops in smooth pipes.

**Fundamentals:** Pressure drop per foot of straight pipe is

$$P = \frac{\lambda V^2 w}{24 gD} = \frac{0.000129 \lambda V^2 w}{D} \quad (1)$$

or, alternatively,

$$P = \frac{\lambda V^2 w}{4 Bg \sqrt{\frac{A}{\pi}}} = \frac{0.001165 \lambda V^2 w}{\sqrt{A}} \quad (2)$$

Several factors must first be known or selected before either of these equations can be applied.

**Nomenclature**

- $A$ = Pipe area, sq in.
- $D$ = Pipe inside diameter, in.
- $g$ = Acceleration of gravity, 32.2 ft per sec$^2$
- $P$ = Pressure drop, psi per ft
- $Q$ = Flow, gpm
- $R$ = Reynolds number
- $V$ = Velocity, fps
- $w$ = Density of fluid, lb per cu ft
- $\lambda$ = Friction coefficient
- $\nu$ = Kinematic viscosity, centistokes

Velocity $V$ and pipe size, in terms of either area $A$ or inside diameter $D$, are usually established in conjunction with required flow $Q$. These factors are related by either of the following two equations:

$$D = \sqrt{\frac{231(4)\,Q}{720\,\pi\,V}} = \sqrt{\frac{0.4089\,Q}{V}} \quad (3)$$

$$A = \frac{231\,Q}{720\,V} = \frac{0.3208\,Q}{V} \quad (4)$$

These two equations are solved by the nomograph in Fig. 1.

Friction factor $\lambda$ is determined from the Reynolds number $R$ which, however, is dependent upon viscosity $\nu$. That is,

$$R = \frac{7750\,VD}{\nu} \quad (5)$$

For laminar flow ($R \leqq 2000$),

$$\lambda = \frac{64}{R} \quad (6)$$

For turbulent flow ($R \geqq 4000$), the following empirical relationship is applicable:

$$\frac{1}{\sqrt{\lambda}} = 2 \log (R \sqrt{\lambda}) - 0.8 \quad (7)$$

For flow with $R$ between 2000 and 4000, either laminar or turbulent flow may prevail. For this range, designing for turbulent flow is customary.

Equations 5, 6 and 7 are solved by the nomograph in Fig. 2. Viscosity $\nu$ can be determined from data such as shown in Fig. 3.

The remaining term in Equation 1 or 2 is density $w$ of the hydraulic fluid. Since density varies with





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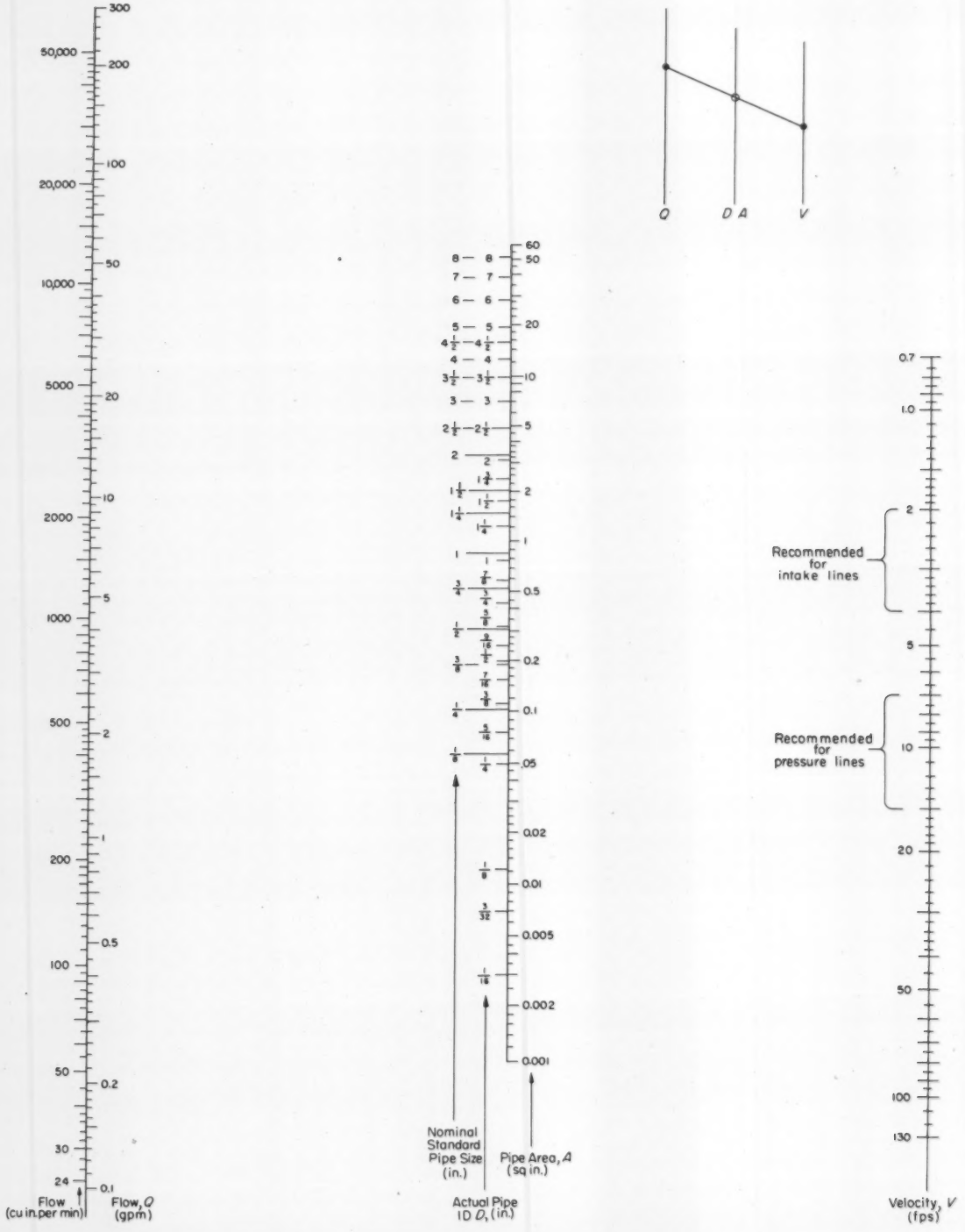


Fig. 1—Nomograph for relating flow $Q$, fluid velocity $V$, and pipe area $A$ or diameter $D$. Recommended velocity ranges are for oil with maximum viscosity of 315 ssu at 100 F, operating between 65 and 165 F.

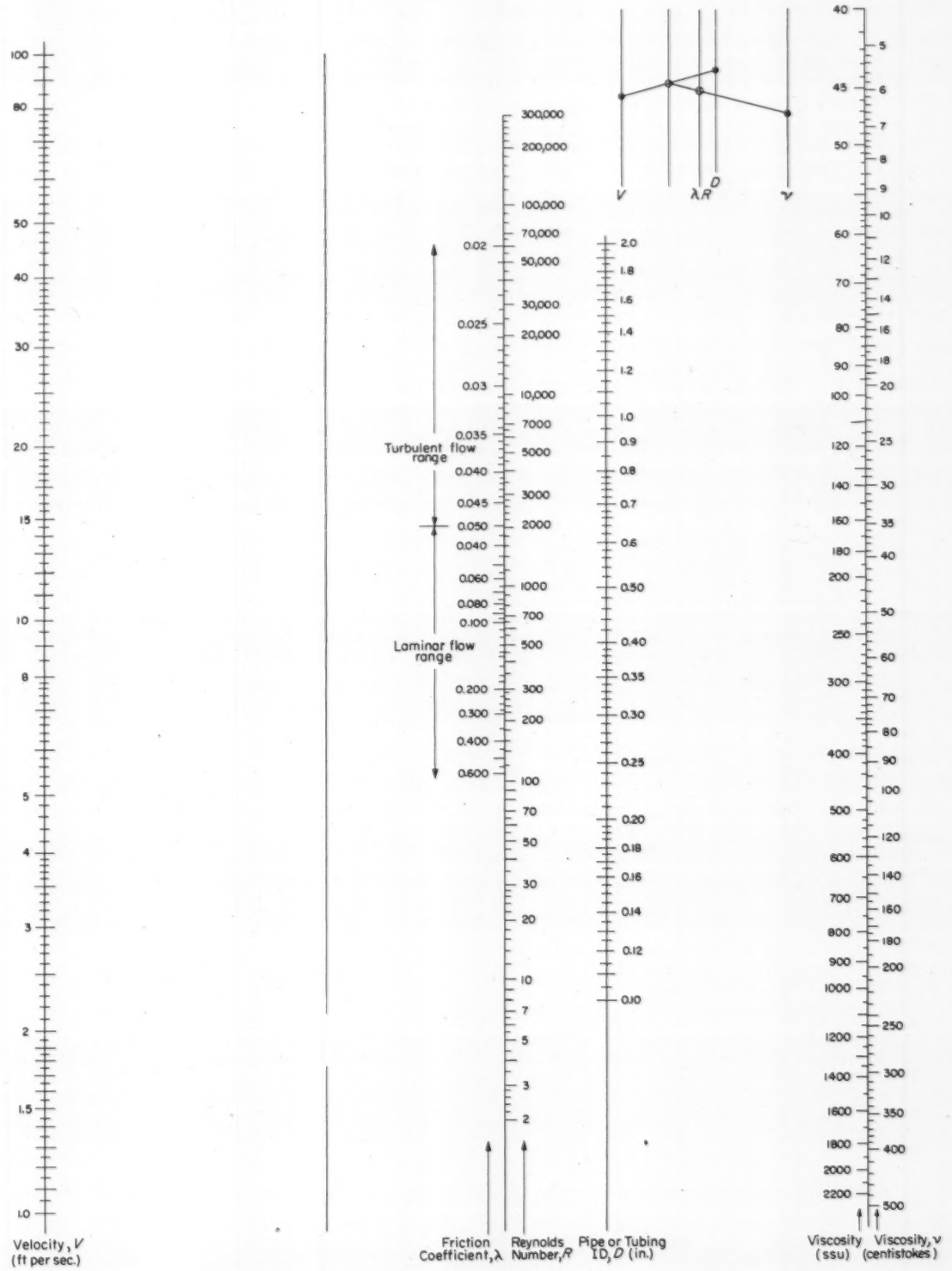


Fig. 2—Nomograph for finding Reynolds number $R$ and friction coefficient $\lambda$ from velocity $V$, diameter $D$, and viscosity $\nu$.



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temperature, data such as shown in Fig. 4 are usually necessary for an accurate solution.

Finally, Equation 1 or 2 can then be solved by the nomographs in Figs. 5 and 6.

**Procedure:** Following steps outline a solution:

1. Find area $A$ or inside diameter $D$ from Fig. 1, starting with required flow $Q$ and velocity $V$. Recommended ranges for intake and pressure lines are indicated on the velocity scale.

2. Determine kinematic viscosity $\nu$ of hydraulic fluid from temperature-viscosity data such as shown in Fig. 3.

3. With known velocity $V$, viscosity $\nu$ and inside diameter $D$, find friction coefficient $\lambda$ and Reynolds number $R$ from Fig. 2.

4. Find fluid density $w$ from temperature-density data such as plotted in Fig. 4.

5. With $\lambda$, $w$, $V$, and $D$, find pressure drop $P$ from Fig. 5 or Fig. 6. Use Fig. 5 if $R$ is 110 to 2000, Fig. 6 if $R$ is 2000 to 20,000.

6. Finally, multiply $P$ by length of pipe to obtain total pressure drop.

**Example:** Determine the pressure drop in the intake line of a pump supplying 15 gpm of DTE light oil at 60 F. The pump inlet line is 4 ft of straight pipe and the permissible pressure drop in the line is 6 in. hg or about 3 psi.

Assume that velocity $V = 3.25$ fps will be satisfactory, since this value falls within the recommended range shown on Fig. 1. Then, on Fig. 1, join $V = 3.25$ fps and $Q = 15$ gpm, and read inside diameter $D = 1.38$ in. Actually, for a nominal standard pipe size of $1\frac{1}{4}$ in., $D = 1\frac{3}{8}$ in.

Next, Fig. 3 shows that at 60 F, kinematic viscosity $\nu = 100$.

In Fig. 2, with $V = 3.25$, $\nu = 100$, and $D = 1.38$, the solution (see key on chart) leads to Reynolds number $R = 350$ and friction coefficient $\lambda = 0.18$.

In Fig. 4, density $w = 54.8$ lb per cu ft for DTE light oil at 60 F.

Since $R$ is less than 2000, use Fig. 5 to determine pressure drop, following steps shown by the key on the chart. With $\lambda = 0.18$, $w = 54.8$, $V = 3.25$, and $D = 1.38$, the pressure drop per foot of pipe is found to be 0.095 psi. Or, for the full length, the total pressure drop is $4(0.095) = 0.38$ psi which is well below the specified limit.

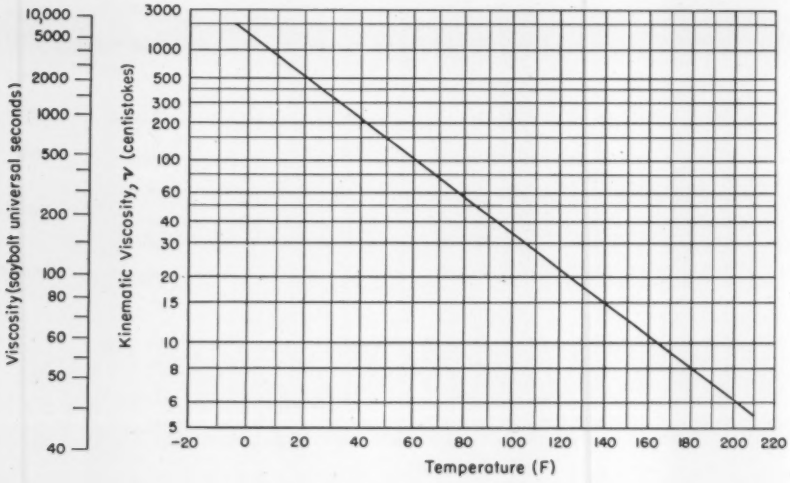
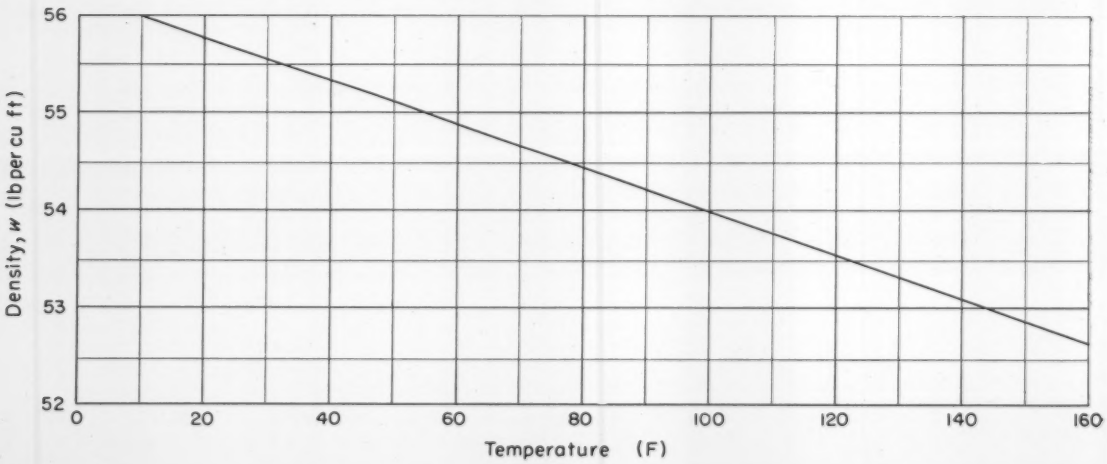



Fig. 3—Left—Temperature-viscosity chart for DTE light oil. Similar data for other hydraulic fluids are commonly available from refiners.

Fig. 4 — Below — Temperature-density chart for DTE light oil.



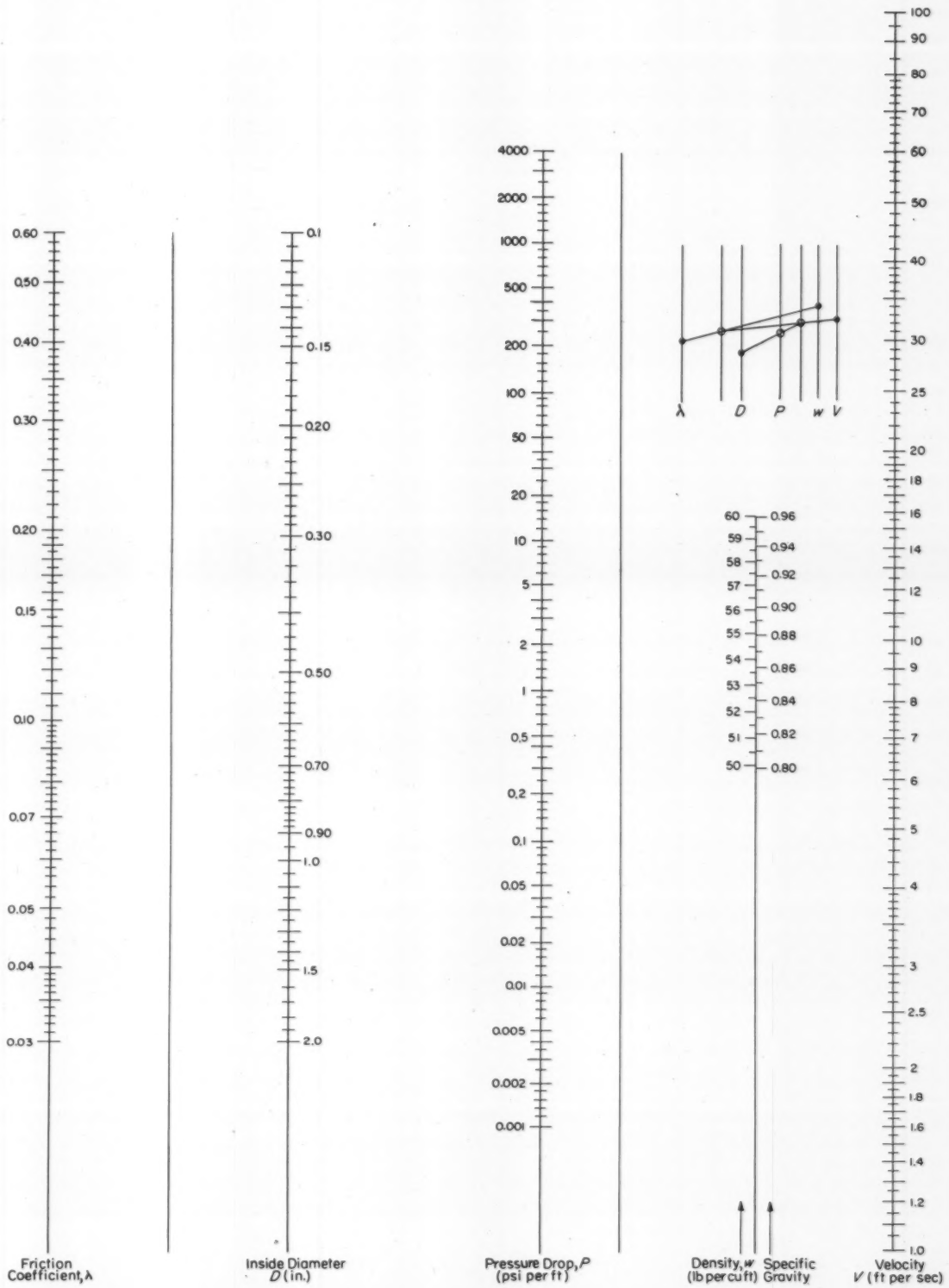



Fig. 5—Nomograph for finding pressure drop $P$ (psi per foot) from friction coefficient $\lambda$, density $w$, velocity, $V$, and diameter $D$ for laminar flow ($R \leqslant 2000$).



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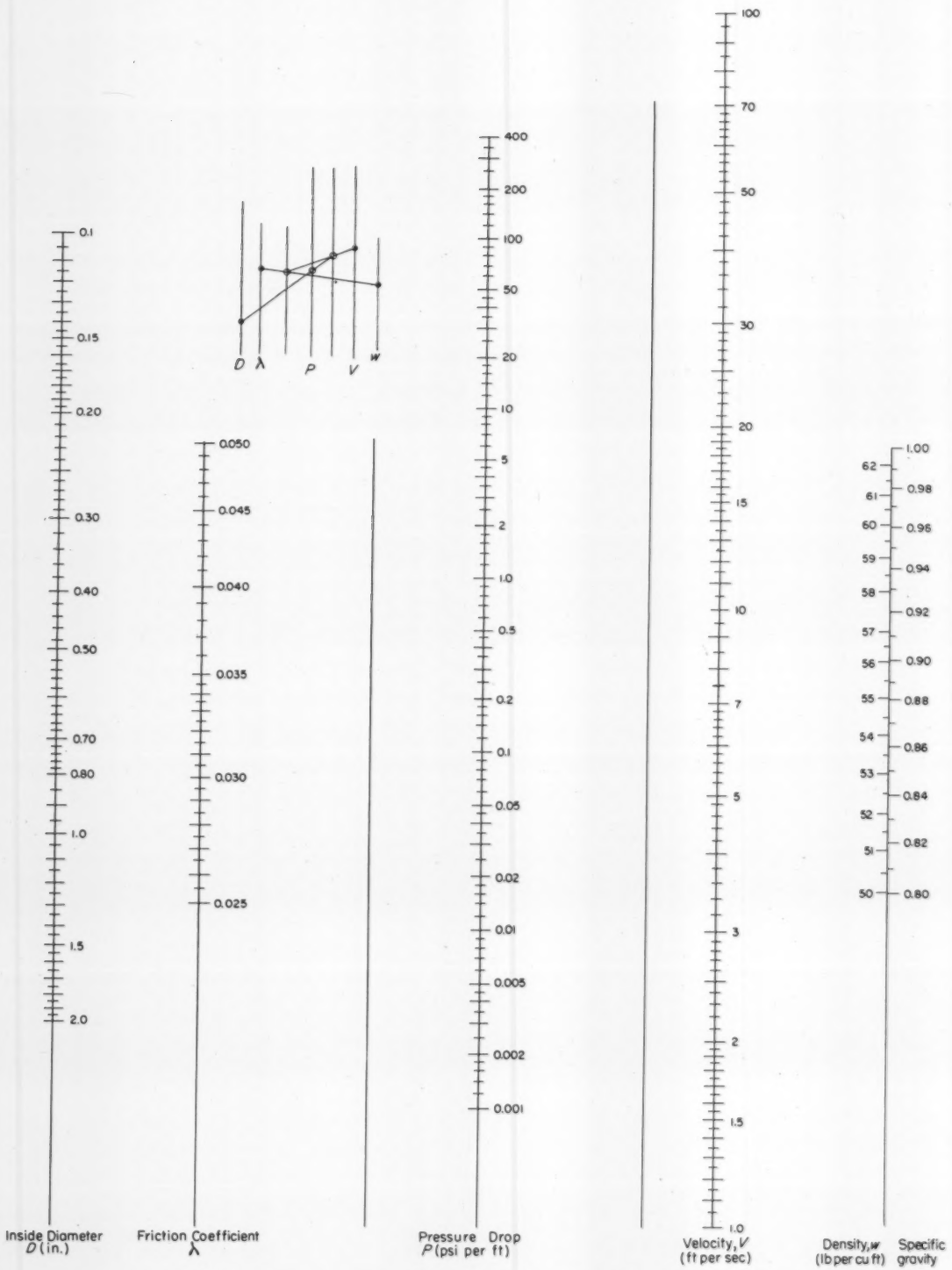


Fig. 6—Nomograph for finding pressure drop $P$ for turbulent flow ($R > 2000$).

*Basic principles of*

DESIGN ABSTRACTS

# Computers for Controls

By J. James Stone Jr.
*Chief of Electrical Engineering Div.*
*Battelle Memorial Institute*
*Columbus, Ohio*

COMPUTERS that handle information as continuous variables are referred to as analog computers. In general, the magnitude of a single quantity in a computer, such as voltage or current, represents the magnitude of the information being handled.

A computer that handles and operates upon information of a discrete variable type is called a digital computer. A single quantity, such as a voltage or a current, is not used in a digital computer to represent the entire magnitude of the information handled. In the majority of cases, voltages and currents are limited to being either present or absent, on or off, and can exist in the computer in only these two states. A combination of a large number of these quantities is employed to represent the numerical amount being operated upon. A four-decimal digit number may require as many as sixteen of these voltage variables for its representation within the computer.

**Analog-Type Computers:** There are two basic types of electronic analog computers, the first of these being called the direct analog. For this computer, a direct analogy exists between the electrical components and the physical components of the system to be analyzed. For example, in the case of a spring-suspended mass, electrical inductance is equivalent to the inertia of the mass, electrical resistance is equivalent to the friction, and electrical capacity is equivalent to the elasticity of the spring. These are the fixed parameters. Likewise, voltage is equivalent to force, current to velocity, and total electrical charge to position.

Large direct-analog facilities have been developed for the study of physical systems. Notable among these are the ac network analyzers for electrical distribution problems and fluid network analyzers for the analysis of gas and water distribution systems.

The second type of analog computer is the operational analog. As the name implies, this computer consists of a collection of electrical building blocks, each performing some basic operation upon the voltages connected to it. Electronic building blocks have been developed, and are commercially available, that perform such operations as addition, subtraction, integration with respect to time, differentiation with respect to time, multiplication, division and others. Networks of these operational units may be devised and assembled that represent equations for the motion or state of physical systems.

Answers are obtained from analog computers in the form of curves or graphs. Often these curves are produced by plotting devices, such as strip chart recorders. In other cases, the curves are displayed on oscilloscopes and recorded photographically.

Input information may be derived from data in the form of curves. Special devices have been developed for converting a plotted curve automatically into an equivalent electrical voltage for driving the input analog computer.

In general, all operations in an analog computer proceed simultaneously. This necessitates using as many operational units in the study of a problem as there are operations to be performed. The number of operational units, therefore,

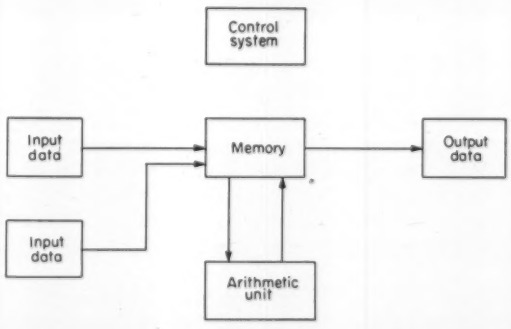


Fig. 1 — Left — Diagram of typical digital computer system.

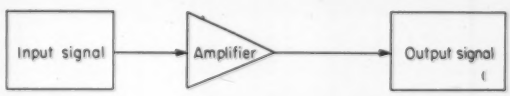


Fig. 2 — Above — Open - ended control system.



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limits the complexity of the problem that may be handled by a single facility. This has led to the assembly of large computing facilities containing up to 1000 operational units. The average-sized facility, however, contains 50 to 100 units. Since the majority of the basic operations use a special amplifier, most facilities are rated in accordance with the number of amplifiers included.

**Digital - Type Computers:** As shown by the block diagram in Fig. 1, a digital computer consists of the following major components:

1. An input device for presenting the information and instructions to the automatic system in a usable form. These input units may be such devices as:

   a. Typewriters
   b. Punched paper tape readers
   c. Punched paper card readers
   d. Magnetic tape readers

2. A memory system for the storage of information, intermediate results and instructions. This system may employ such devices as:

   a. Magnetic drums, tapes, or cells
   b. Acoustic delay lines
   c. Electrostatic storage tubes
   d. Vacuum tube circuits

3. An arithmetic unit for the computational operations.

4. An output device for transferring the information obtained through the computing process to the operator in a form suitable for his use. These devices are similar to those used for the input.

5. A control unit for the co-ordination of the operations of each of the above units.

**Digital-Analog Devices:** Where a digital computer forms part of a control system or is used in the processing of information obtained from a continuous process, there must be a conversion at some point from analog data to digital data. A machinist makes this conversion when he measures a distance or dimension with a scale and assigns a number to describe this quantity. Meters, dials, nomographs, slide rules, and other measuring aids do a similar task.

To effect the automatic flow of data from continuous processes to digital computing systems, analog-to-digital converters have been developed. As an example of such a converter, one unit converts a shaft position to digital form through the use of an electrical commutator assembly. A single input voltage is delivered, by means of this commutator, to a selected number of the output connections. The output terminals receive this voltage change as the input shaft to the commutator rotates and represents the numerical value of the degrees of rotation of the shaft. Other examples may likewise be chosen for the conversion of electrical signals, translation, velocity, temperature, weight and others into numerical form.

Having a digital computing system control a continuous process often requires the conversion of digital information into analog form. Fortunately, devices are also available to reverse the previous operation and close the loop in the control system.

Other machines have been devised to transcribe information from one form into another that is more usable by the operators. As an example, one such machine receives numerical data through a keyboard and plots these data as points on a graph. Other devices assist the reading of a curve by printing in digital form the information obtained from a graph or curve. Both these machines assist operators in the reduction of data already recorded in one form or another and do not represent, as did the preceding ones, a link in the continuous flow of information in a system.

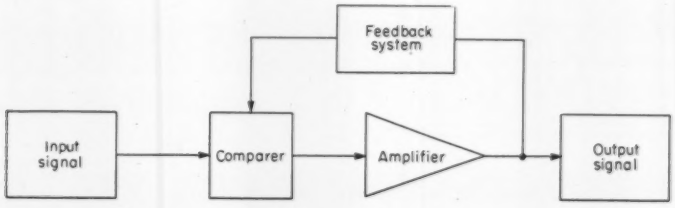


Fig. 3—Closed-loop control system.

**Digital Versus Analog:** The majority of modern control systems utilize continuous variables and employ analog-type computational systems. The servo-control systems exemplify this type of system and the use of complex feedback networks, as explained more fully in the next section, represents a simplified analog-type computer.

As the links become available for the inclusion of a digital computer as a portion of a control system, a debate arises regarding the relative merits of each. Many factors influence the decision as to which machine, the digital or the analog, performs best in a given application. These factors include such considerations as accuracy, flexibility, complexity and reliability, and these must be evaluated in terms of ultimate cost. Each consideration depends upon the specific application and those that may be important under one set of conditions may be neglected for others.

Accuracy, for instance, is normally considered as being considerably greater for digital computations than for analog computations. This comes from the fact that a large number of digits may be used to represent a numerical quantity to a high degree of precision. Some error is introduced in each basic operation in a digital computer where roundoff of results occurs and for a large number of such operations, the roundoff errors may accumulate. Furthermore, the availability of 10 digits does not provide assurance that these digits will be used in an effective manner. It is possible, for example, to use 10 digits as .0000000561 where only the latter three carry any significance.

In general, however, the overall accuracy of an analog computer system is limited and may be of

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the order of 0.1 per cent of the full scale value of the variable concerned. The accuracy of a digital system is limited by the digit capacity, but this capacity may be extended easily by adding additional circuit elements.

Flexibility and complexity may be determining factors. Certain operations may involve the storage of information and a recall of this information at a later point in the cycle. A digital system is the only one that provides memory without leading to complex circuit arrangements. Again, the ability to control the operating features of a digital computer by means of numerical input information may lead to a greater degree of flexibility. Furthermore, many analog systems may be simply constructed and may cost far less than the barest minimum of digital computing equipment.

Reliability, or dependability, becomes a more serious problem as the complexity of a system increases. Digital computers involve many circuit components and a very low probability of failure is required of each to assure proper operation over extended periods. Many errors produced by circuit failure in a digital computer are difficult to detect and may be serious in their consequence. Failure of a single component in analog computers, on the other hand, more frequently result in complete failure of the machine's operation. These errors are easily and quickly detected. Drift in the operating characteristics of an analog computer produces errors of rather small magnitude but these may affect the dependability of the results.

**Basic Control Systems:** In designing or analyzing control systems, there are two basic types. The first of these, shown by the block diagram of Fig. 2, is open-ended. In this system, the input signal is amplified, or modified, by the controlling amplifier to produce the output signal. The input signal may, in this diagram, be considered to be a demand signal such as a demand for a given position, or a demand for a given speed. The output signal may be considered as representing the change produced in the article being controlled, such as a change in its position or a change in its speed. In this case, the amplifier is considered as containing both the components for power amplification or control and the mechanism for producing the desired change.

For the open-ended system, the accuracy of the change produced, compared to the demand, depends upon the calibration of the amplifier and the extent to which the amplifier might drift. Likewise, the load conditions on the article being controlled may affect the amount of change produced for a given input signal.

To overcome this difficulty in the open-ended system and to improve the overall accuracy of the system, a closed-loop system was developed. Fig. 3 shows in block form the nature of this type of control. The input signal for this circuit connects with a comparer circuit along with a portion of the output signal. The difference between the two signals connected to the comparer is amplified and used as the output. For this reason, the amplifier gain should be sufficiently high to reduce the required input from the comparer to a value below the error limits imposed on the system. By this means, the two inputs to the comparer are forced, in essence, to be equal and the accuracy of the output signal becomes dependent upon the feedback circuit rather than upon the amplifier.

The accurate control of motor speed often involves this second method of control. An electrical voltage is produced that is equivalent to the desired speed of the system. A second voltage is produced by a tachometer that is equivalent to the actual speed of the system being controlled. The difference between these two signals is amplified and used to control the voltage source for the driving motor. By this means, if the output speed tends to increase, the difference signal is decreased and the voltage applied to the control motor is reduced, thus maintaining an approximately constant output speed.

Feedback may occur in many other ways. The machinist, for example, provides the feedback in a manual control system of a machine tool. He measures the item being machined and adjusts the cutting tool to compensate for any error between the actual dimension being produced and the dimension desired. Computing systems may provide feedback for control systems in more complex ways. In addition, computing systems may form part of the amplifying unit in Fig. 3.

Fig. 4 shows one method by which a digital computer might be employed in control. In this system, a numerical input signal is placed in the upper storage unit. The output signal, as converted to numerical form, is placed into a second storage unit. The comparer provides the computing circuit with the difference between these two numbers. The computer then, through programming in advance by the operator, determines the action to be produced in the controlled circuit. It is not necessary in this system that the output be proportional to the difference signal at the input to the com-

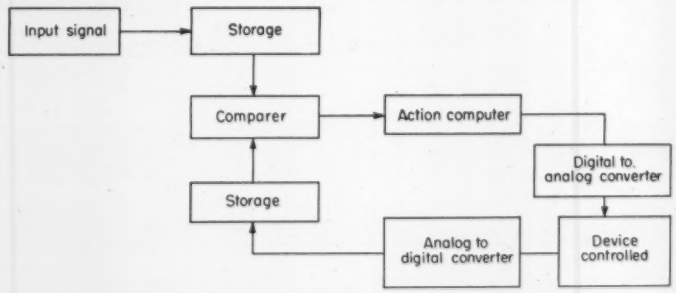


Fig. 4—Example of control using digital computing elements.

puter. It is necessary that the output action should be capable of being determined in some logical manner. In a hypothetical case, a package-filling machine may be filling, to a predetermined weight, a package with an assortment of ingredients. If each of these ingredients has a nominal weight differing from each of the others, it would be possible, after the weight of ingredients needed is measured, to compute the quantity of each ingredient so that the total weight added comes closest to that desired. The procedure for carrying out the necessary computations may be formulated into equations. By including a computer in the control system for the filling machine, the amount of feed for each ingredient may be immediately and automatically determined and the feeders actuated automatically.

**Discrete Variable Machine Tools:** The majority of machine tools operate through continuous drive mechanisms and controls. The tool feed on a lathe, for example, moves continuously as the control crank is rotated. To employ digital control in these machines requires the inclusion of analog-to-digital and digital-to-analog converters as elements in the control system.

Through the development of machine tools that function in discrete steps, there is a possibility of simplifying the digital control of machine tools. The developments required include both intermittent motion of drive mechanisms as well as intermittent motion in the sensing devices that provide feedback for control.

Mechanisms are presently being used that provide the required drive from either an input shaft that moves continuously to a driven shaft which moves intermittently or from an input shaft that moves intermittently to an output shaft which moves in a like manner. Two examples are ratchets and Geneva mechanisms.

*From a paper entitled "Introducing Computers for Machine Tool Control" presented at the ASTE Annual Meeting in Chicago, March,* 1956.

# Silicone Rubber

By S. A. Braley Jr.
*Assistant Manager*
*Silastic Development*
*Dow Corning Corp.*
*Midland, Mich.*

SILICONE rubber is used successfully as insulation for the stator windings of large electric motors and generators. It has proved valuable not only for its dielectric properties, but also because of its increased thermal stability and moisture resistance. Silicone rubber has higher thermal conductivity than many other insulations, which aids in dissipating heat. This type of insulation is flexible, resilient and shock resistant, so that the unit can withstand vibration and the constant expansion and contraction of adjoining metal parts.

Encapsulation of many kinds of transformers and small coils with silicone rubbers that are fluid in the unvulcanized form has provided waterproof, heat resistant, insulated units. Hundreds of miles of silicone rubber-insulated wire have been made. The rubber not only makes an excellent high-temperature insulation, but because silicone rubber when burned leaves only silicon dioxide, a nonconducting ash, wire coated with it does not short out when burned.

**Low-Temperature Features:** Silicone rubber also is useful at much lower temperatures than other elastomers. All dimethyl silicone rubbers have a brittle point at about −180 F. This ability to remain flexible at very low temperatures has enabled silicone rubber to be used in many places where rubbery seals are needed on today's high-flying aircraft. Since these extreme low-temperature silicone rubbers also will operate at 500 F, the aircraft engineer is able to simplify his designs to a degree impossible with more thermally responsive rubber.

**Tensile Strength:** The tensile strength of silicone rubber is considerably higher at low temperatures than it is at room temperature. Silicone rubber is not damaged by freezing. It can be cycled from room temperature to below its freezing point many times with no change in ultimate properties.

**Effect of Ozone:** Silicone rubber is unaffected by weathering or ozone action. Test samples have been exposed in southern Florida for upwards of five years with no change in appearance or physical properties. It can be subjected to intensely high ozone concentrations for long periods and show no demonstrable change in properties. Because of these two properties, it has been used in high-altitude equipment where organic rubbers deteriorate rapidly because of increased ultraviolet radiation and high ozone concentration.

**Chemical Resistance:** The resistance of silicone rubber to chemicals and oil varies with the particular material being tested. It is destroyed by hot, concentrated acids and alkalies, although it has good resistance to weak or cool solutions of these chemicals.

In aromatic solvents, such as benzene or toluene, and in chlorinated solvents such as perchloroethylene, silicone rubber swells badly, although upon evaporation of the solvent it returns to its original condition undamaged. The lower alcohols tend to swell it. It is quite resistant to some oils and is badly affected by others. In general, the high-aniline-point oils have little effect, while the low-aniline-point oils are bad. Hot ASTM No. 3 oil will deteriorate silicone rubber while No. 1 oil has little effect. Because of this latter property, it has been used very widely in the diesel-electric field as O-rings operating against hot lubricating oils.

*From a paper entitled "Properties and Applications of Silicone Rubber" presented at the ASME Semi-Annual Meeting in Cleveland, June,* 1956.



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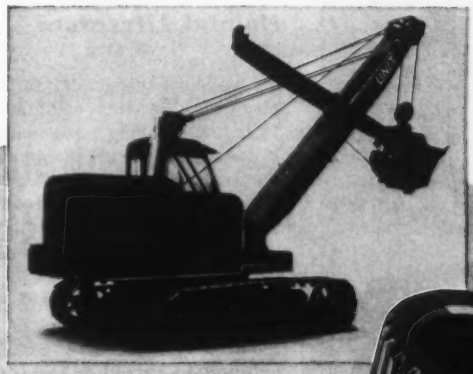

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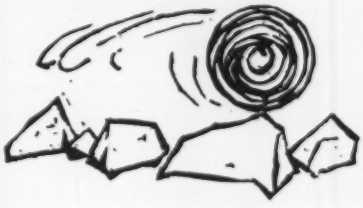

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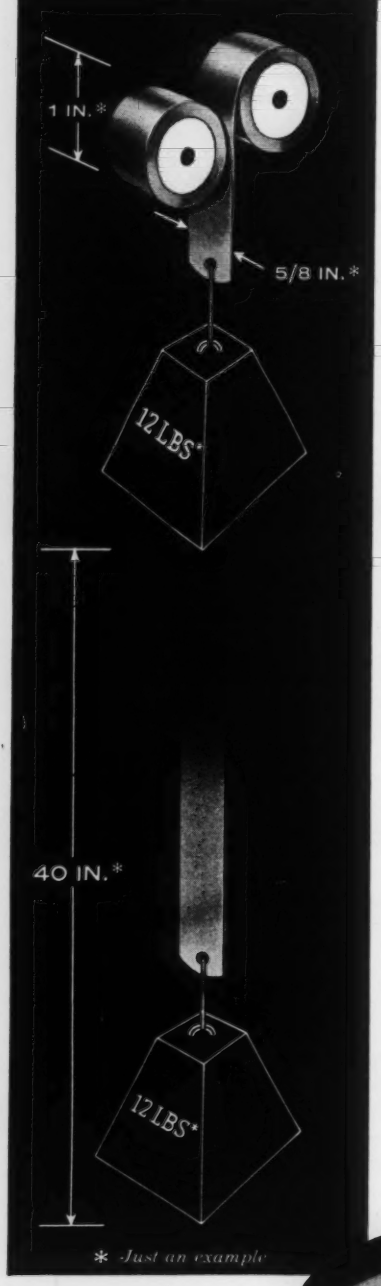
**BALANCE IT** *with a*
**NEG'ATOR®** *constant-force spring*




NEG'ATOR is the name of a new kind of spring—the coiled-band spring that extends many times its original size without the increasing force common to conventional springs.

One of the natural uses of the NEG'ATOR Spring is counterbalancing without mass—vertically as illustrated, or horizontally. Using the NEG'ATOR Spring, the design engineer can eliminate dead weights or linkages and gain space, freedom of motion, reduced over-all weight, simplified assembly.

For example, each of the NEG'ATOR Extension Members used back-to-back in the illustration measures about 1 inch in diameter when coiled. They will counterbalance a 12 lb. weight over about 40 inches of travel. The only force required to move the weight is that required to overcome friction in the mechanism. There is no intercoil friction in the NEG'ATOR Spring.

NEG'ATOR Springs in extension or motor form are versatile in counterbalancing functions—are now being used to balance light tank floats in sensitive liquid-level indicators and fire doors and other heavy equipment. Extensions range to over 20 feet.

Used as an extension spring, a motor, band, clamp, or clip—this revolutionary new *constant-force* component upsets all previous spring principles, opens a whole new field of mechanical design by doing what springs have never done before.

These and other functions of Hunter NEG'ATOR constant-force springs are described in Bulletin 310N, "The Story of the NEG'ATOR Spring." Send for a copy.

**HUNTER SPRING COMPANY**
*3 Spring Avenue, Lansdale, Pennsylvania*
SPRINGS • STAMPINGS • TEST APPARATUS

Circle 566 on page 19


## Helpful Literature

motors and types AP and APWW nonrerated motors of ½ to 100 hp are described in bulletin 51B6210G. Diagonally split cast iron conduit box for ease of wiring and leads with attached metal markers are featured in the rerated units. 6 pages. Allis-Chalmers Mfg. Co.

Circle 422 on page 19

### Seamless Fittings & Flanges

Folder FB-502 provides brief description of line of carbon alloy and stainless steel seamless welding fittings and forged steel flanges for pressure pipe line application. Flanges include welding neck, slip-on, lap joint, threaded, blind and reducing types in ratings up to 2500 psi. 6 pages. Babcock & Wilcox Co.

Circle 423 on page 19

### Instrumentation Systems

How instrumentation systems are created for industrial control, chemical analysis, dynamic and static testing and high speed electronic data processing is related in brochure on the Systems Division of this company. Several case histories are given. 16 pages. Consolidated Electrodynamics Corp.

Circle 424 on page 19

### DC Power Supplies

Technical data for six standard regulated direct-current power supplies for intermittent, variable and pulse loads, or high-amperage loads are provided in bulletin CV-235. These supplies combine constant voltage transformer, a germanium power rectifier and high-capacitance filter without choke. 8 pages. Sola Electric Co.

Circle 425 on page 19

### Pearlitic Malleable Iron

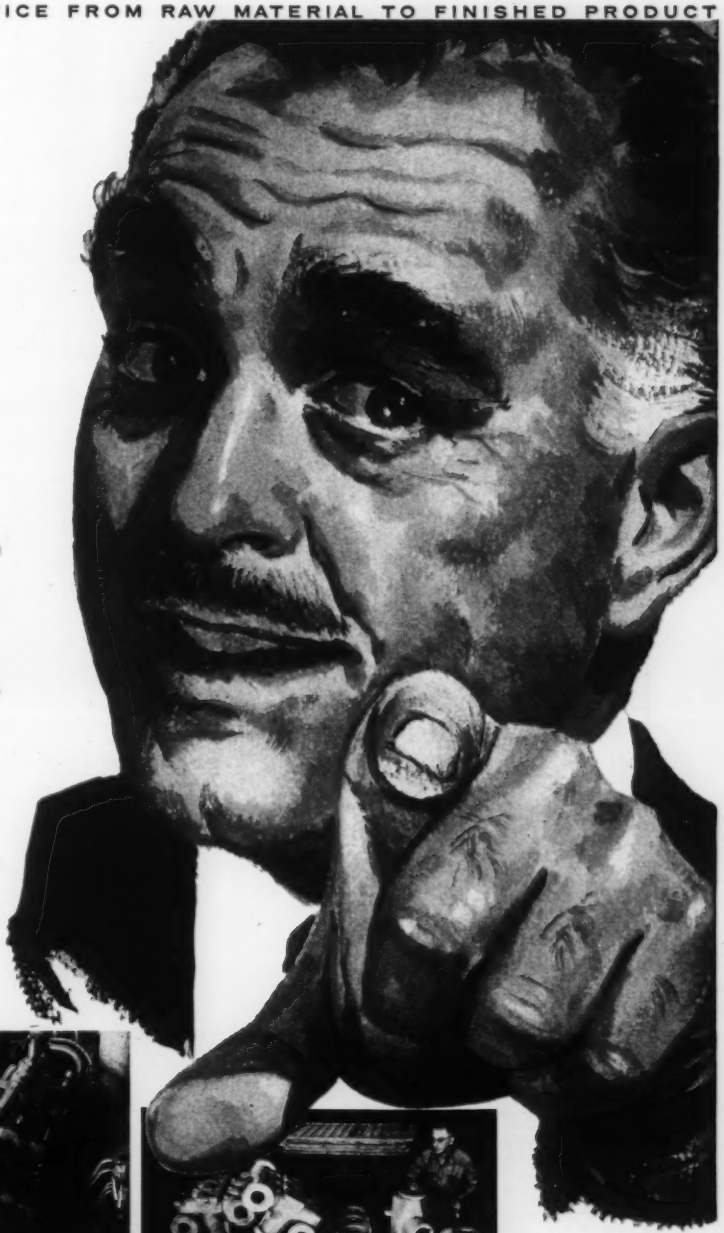
Metallurgical characteristics, specifications, mechanical properties, hardenability, surface hardening, machining power requirements, surface finish tool life, elevated temperature properties, manufacture and application of "Pearlitic Malleable Iron" are discussed in brochure of this title. Castings are used for highly stressed parts. 24 pages. Albion Malleable Iron Co.

Circle 426 on page 19

### American Standards

Booklet "How American Standards Are Made" describes three ways standards become nationally accepted and approved and tells who makes these standards and why, and who uses them. Operation of the American Standards Association is explained. 20 pages. American Standards Associ-

**AMPCO — ONE-SOURCE SERVICE FROM RAW MATERIAL TO FINISHED PRODUCT**



## You're the *boss* when you design with Ampco Alloys

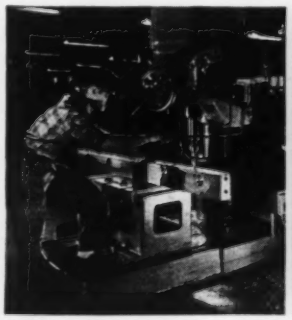
### You're not limited to a single copper-base alloy or a single form

Your design behaves the way you want it to, after it takes shape in one of more than 100 Ampco alloys.

Why? Because whether you are looking for resistance to wear, impact, fatigue, or corrosion, Ampco has a tailor-made alloy to meet your requirements.

And besides, you have flexibility in selecting the most economical form of production. Why? Because Ampco is available in sand-cast, centrifugally-cast, shell-molded, precision-cast, fabricated, forged, extruded, and sheet and plate forms. A call to your nearby Ampco field engineer will get you an unbiased recommendation.

Write for Bulletin 33 describing the Ampco Metal series of alloys.



**Ampco's one-source service** includes production-run machining of Ampco copper-base alloys to the quality standards of the aircraft industry.

**2,275-ton hydraulic press** in Ampco's modern, laboratory-controlled mill for extruding rods, bars, hollow rounds, and shapes.

**Meter housings and fluid ends.** Ampco produces sand castings like these up to 14,000 pounds — and centrifugal castings up to five tons.

AMPCO METAL, INC. Dept. MD-10 Milwaukee 46, Wisconsin • West Coast Plant: Burbank, California

AMPCO® **THE METAL WITHOUT AN EQUAL**

SAND CASTINGS

CENTRIFUGAL CASTINGS

FABRICATIONS

CAST-TO-SIZE CASTINGS

FORGINGS

SHELL-MOLDED CASTINGS

EXTRUSIONS

SHEET AND PLATE

MACHINED PARTS

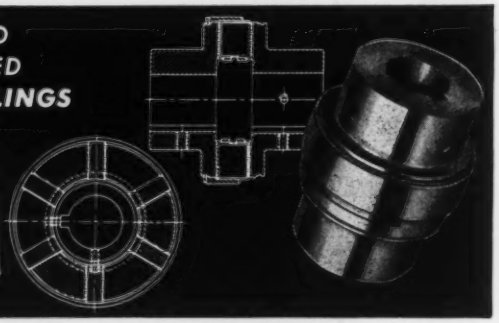
D-55

LOVEJOY

Power Transmission Equipment

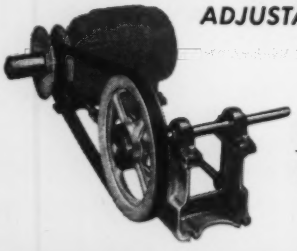
Job-Rated for the Particular Load to Give Maximum Performance on Your Job

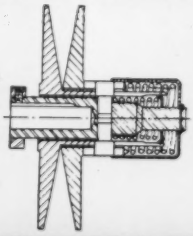
NON-LUBRICATED
EASILY-ASSEMBLED
FLEXIBLE COUPLINGS



Bores (max.) .....⅜" to 9½"
O.D. .....⅝" to 21½"
Wt. .....½ oz. to 1500 lb.
H.P. .....1/20 to 3000
Torque (static)..1½ to 5100 ft.-lbs.

MAINTENANCE-FREE INSTANTLY-ADJUSTABLE VARIABLE SPEED PULLEYS

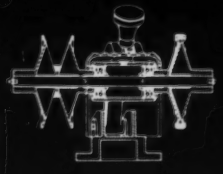




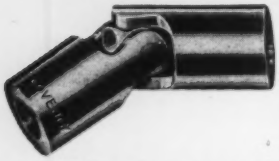
Bores (max.) .....½" to 1⅜"
O.D. .....3" to 13¾"
Belt Sizes.....A to 2¾ TW
Speed Ratios.....1-1 to 8-1
H.P. (1750 rpm.)....¼ to 15

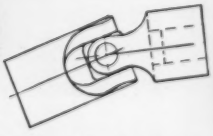
ECONOMICALLY-PRICED INFINITELY-VARIABLE SELECT-O-SPEED TRANSMISSIONS

Controls . Lever or Hand Wheel
Belt Sizes.....A to C
Speed Ratios.....1-1 to 10-1
H.P. (1750 rpm.)...½ to 7½



LIGHT-WEIGHT PRECISION-BUILT UNIVERSAL JOINTS





Bores.....¼" to 2"
Hub Dia. .....½" to 4"
Static Torque
340 to 130700 in.-lbs.
H.P. (100 rpm.).....½ to 207

Get Lovejoy performance for your equipment.
Request full information now.

LOVEJOY FLEXIBLE COUPLING CO.

4818 WEST LAKE STREET • CHICAGO 44, ILLINOIS

Circle 568 on page 19


## Helpful Literature

ation, 70 E. 45th St., New York 17, N. Y.

Circle 427 on page 19

### Fluid Power Equipment

"Faith in an Idea" is title of attractive 35th anniversary booklet which points up the history and current applications of Oilgear fluid power variable speed transmission equipment. Photos introduce the precision machines used in the manufacture of these products. 24 pages. Oilgear Co.

Circle 428 on page 19

### Progress Without Guesswork

Means by which this company can help you improve your competitive position are described in illustrated bulletin "Your Next Move for Profit and Progress." Company offers equipment for dynamic and static testing, chemical analysis, process monitoring and control, leak detection, systems engineering, high vacuum technology and electronic data processing. 20 pages. Consolidated Electrodynamics Corp.

Circle 429 on page 19

### Printed Circuit Connectors

Expanded line of printed circuit receptacles designed for 1/16, 3/32 and ⅛-in. printed circuit boards is outlined in technical brochure. Series includes types with 6, 10, 15, 18, 22 and 28 contacts in single or dual rows to accommodate up to 56 connections. 12 pages. DeJur-Amsco Corp., Electronic Sales Div.

Circle 430 on page 19

### Hot Pressed Forgings

Design, properties and applications of brass, bronze and aluminum hot pressed forgings are evaluated in illustrated booklet. Design factors involved in specifying and producing forgings are included. Advantages of using such forgings, available alloys and their properties and other data are included. 32 pages. Request on company letterhead from Titan Metal Mfg. Co., Bellefonte, Pa.

### Radial Roller Bearings

Latest research data of Rollway engineering is combined with current standards of Roller Bearing Engineers' Committee in catalog-manual "Precision Radial Roller Bearings." Static and dynamic capacities are tabulated, as are thrust capacities. Detailed application data include load ratings, temperature allowances, seals, and lubrication. 56 pages. Request on company letterhead from Rollway Bearing Co., 541 Seymour St., Syracuse, N. Y.

W. B. KNIGHT MACHINERY COMPANY

MANUFACTURERS OF

MILLING MACHINES - JIG BORERS

SPECIAL MACHINERY

3920 WEST PINE BLVD.

ST. LOUIS 8, MO

Mr. Paul E. Travers,
Sales Manager
Baldor Electric Co
4353 Duncan Avenue
St. Louis 10, Mo

Dear Mr. Travers:

"Because of their excellent performance over the years, we supply Baldor Motors as standard equipment on our rotary tables.

"To the best of my knowledge we've never replaced a Baldor Motor in 10 years even though our rotary tables take some mighty tough treatment year after year.

"Naturally, we're very pleased with this remarkable record of trouble-free performance."

Yours truly,

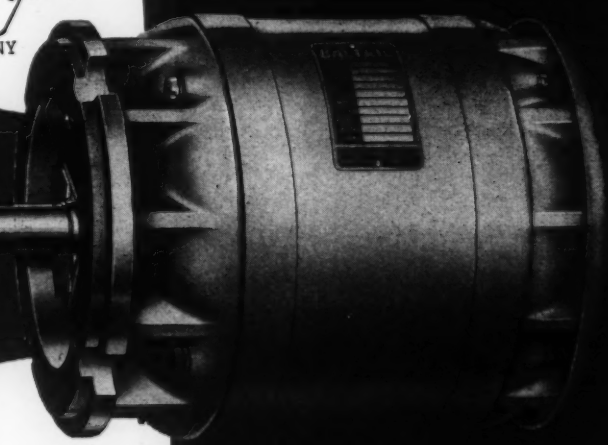
By H. B. Knight

W. B. KNIGHT
MACHINERY COMPANY

# ..."we've never replaced a Baldor Motor in 10 years".....

Baldor

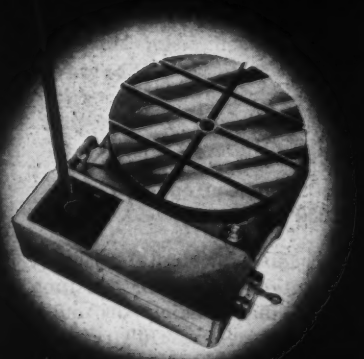
STREAMCOOLED MOTORS



Mr. Knight's comments are typical of manufacturers who rely on Baldor Motors to power their equipment.

For over a third of a century Baldor has supplied original equipment manufacturers with motors of uncompromising quality . . . the kind of quality that requires *every* motor to be *individually* balanced and tested—*not just spot checked!*

If your customers demand this *extra* touch of quality, contact Baldor. Their engineering service is available . . . *without obligation!*



Knight's 20" Rotary Table for Milling & Indexing. Powered by a ¼ HP or ⅓ HP Baldor Motor.

**BALDOR ELECTRIC COMPANY**

**4353 Duncan Avenue • St. Louis 10, Missouri**



XUM

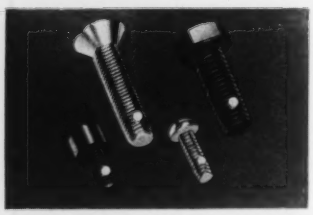
# New Parts and Materials

Use Yellow Card, page 19, to obtain more information

## Self-Locking Screws

**seal against loosening or fluid leakage**

Self-locking, self-sealing Nylok screws, bolts, and similar threaded parts have a locking medium consisting of a resilient, protruding nylon pellet permanently inserted in the body of the threaded section. When mating parts are engaged, spring-like wedging action of nylon pellet locks and seals mating



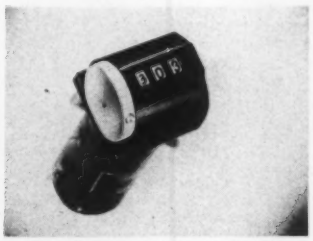
threads together. Locking torque is smooth and uniform with no gall or damage to threads or seating surfaces. Fasteners seal against leakage because nylon pellet acts as an efective dam to flow of oil, hydraulic fluid, water, or air along helical path of threads. Lock can be added to standard or special threaded fasteners of any design. **Nylok-Detroit Corp.**, 308 N. Woodward Ave., Birmingham, Mich.

*Circle 451 on page 19*

## Digital Dial

**gives readout of one part in 2000**

Compact dial for digital read-out of potentiometer rotor position simplifies dial reading of multiturn potentiometers. Unit requires only 1 by $1\frac{1}{16}$ in. of panel space, yet permits accurate digital indexing of ten-turn precision potentiometers with exceptional linearity and precision. Dial consists of



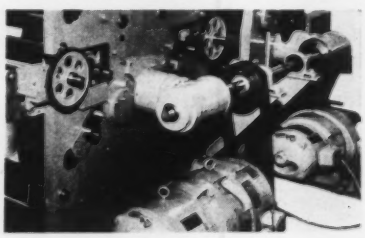
three-digit counter (0 to 999) with provision for mounting on drive shaft of potentiometer. Knurled knob permits rapid, precise adjustment of drive. Detenting in ½-digit increments allows read-out of one part in 2000. Dial can be adapted for use with capacitors, inductors, and similar adjustable devices. **W. L. Maxson Corp.**, Maxson Instruments Div., 47-37 Austell Place, Long Island City 1, N. Y.

*Circle 452 on page 19*

## Variable-Speed Drive

**controls narrow range within 1 part in 3800**

Variable-speed drive gives input-output speed ratios accurate to 1 part in 3800. Unit operates over narrow speed range of ±15 per



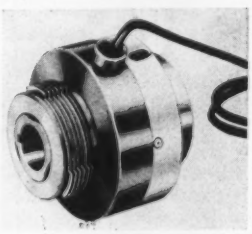
cent of input speed. Speed settings for this range are provided by a micrometer dial having 400 graduations. Accuracy of drive is sufficiently accurate to eliminate necessity for auxiliary differentials and feed-back systems. Drive is designed for register control applications in the printing, packaging, textile, and plastic industries, and for metering and proportioning where extreme accuracy is required. **Graham Transmissions Inc.**, Menomonee Falls, Wisc.

*Circle 453 on page 19*

## Electric Clutch

**gives instantaneous or gradual engagement**

Electric floating disk clutch consists of sealed magnetic coil enclosed in clutch housing and acting through a sleeve and pressure plate to compress wet or dry clutch disks. Electro-magnetic actuating mechanism is stationary, exerting



and maintaining positive pressure on clutch disks entirely by means of magnetic flux without mechanical contact between moving and stationary parts. Mechanism is self-adjusting and self-compensating for wear up to point where disk-pack becomes due for replacement. Clutch gives instant, positive engagement and disengagement to a point beyond the rated load-carrying capacity of the units. Varying the voltage controls the magnetic flux and therefore the pressure exerted on the clutch disks, enabling the unit to pick up or slow down a load gradually from a remote control station. Since the electrical parts do

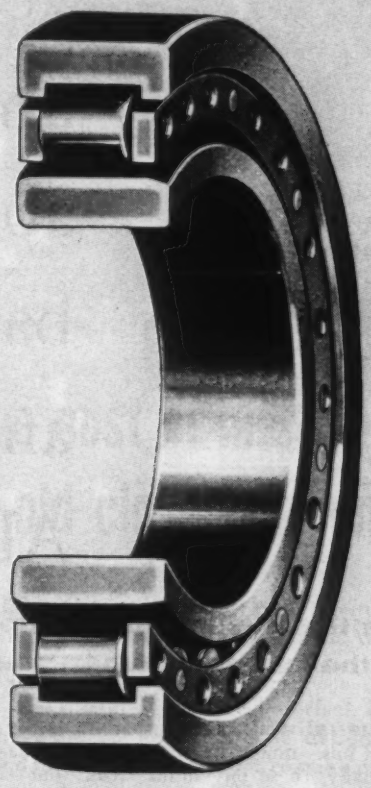
# No job too little . . . or none too tough for BOWER STRAIGHT ROLLER BEARINGS

## A complete line, a wide range of sizes to fit your specific needs

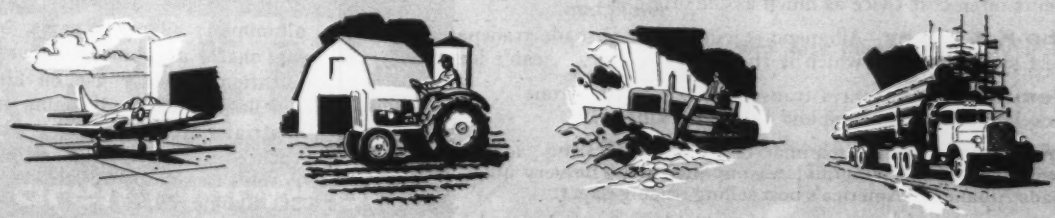
Square pegs weren't made for round holes. And aircraft bearings aren't built for farm equipment, either. That's why Bower designs a complete line of straight roller bearings—a line broad enough to meet any product requirement.

Jet planes break the sound barrier . . . need bearings that'll keep pace. So Bower aircraft bearings are engineered with exactness and precision to tolerances held to millionths of an inch. Bower tractor bearings, on the other hand, are built for ruggedness . . . to take heavy loads and real punishment, day after day, month after month.

Bower Roller Bearings are proved performers *in every field,* for *any* straight roller bearing application. From motors to earthmoving equipment, they're on the job—cutting maintenance and downtime, setting new standards of efficiency and economy. Get details on the *complete* line from a Bower engineer.



**Tapered, Straight and Journal Roller Bearings for every field of transportation and industry**

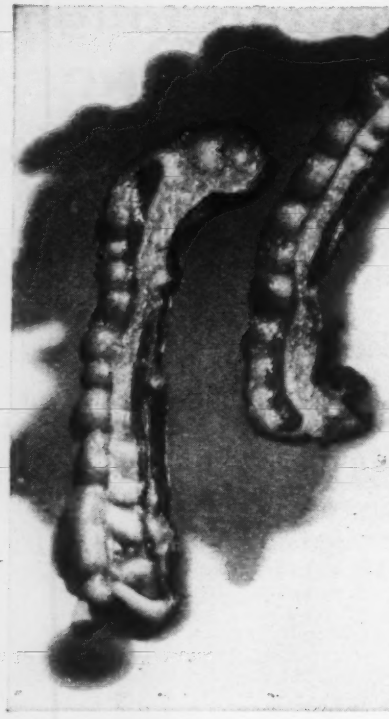


# BOWER ROLLER BEARINGS

*BOWER ROLLER BEARING DIVISION* • *FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICHIGAN*



*Circle 570 on page 19*



what you should know about bacon fat and Albanene

**Here's the buying information you should have to get the *best* value when you buy tracing paper.**

1. **The usual way** of "transparentizing" tracing papers is with waxes or mineral oils—much the way bacon fat makes a paper towel transparent. Eventually, these oily fluids "leak" out—leaving the paper opaque and useless for reproductions.

   **Result:** Valuable drawings on ordinary tracing papers eventually become yellow or brittle—lose their reproduction qualities. And, these days, replacements often cost twice as much as the originals.

2. **The K & E way**—Albanene tracing paper is made transparent with an inert synthetic resin which is chemically stable . . . can't leak out—ever!

   **Result:** Albanene stays transparent . . . stays strong . . . protects every nickel you invest in time and talent working on it.

   **Important:** During manufacture, constant testing *guarantees* uniformity as well as pencil taking and erasing qualities. The very qualities that have made Albanene—America's best selling tracing paper.

**Try Albanene Today** . . . it's available in 3 weights and in rolls, sheets or pads. Try it now . . . it's the best value you can buy!

**89 YEARS OF LEADERSHIP**

In equipment and materials for drafting, surveying, reproduction and optical tooling . . . in slide rules and measuring tapes.

K+E KEUFFEL & ESSER CO.

NEW YORK • HOBOKEN, N. J. • Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles Seattle • Montreal

Circle 571 on page 19


## New Parts

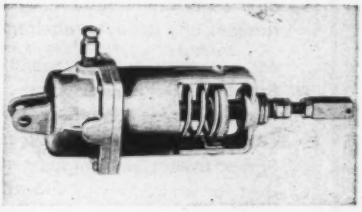
not revolve, there are no collector rings or brushes, electrical connections being made directly to clutch housing. Clutches in all sizes operate on 110-v, single-phase, 60 cycle ac (rectified to 90-v dc) and consume 80 watts. **Carlyle Johnson Machine Co.**, Manchester, Conn.

Circle 454 on page 19

### Diaphragm Motor

**has thrust to 500 lbs.**

Three sizes of gradual-acting diaphragm motors are powered by air, water, or oil pressure. Pressure on molded neoprene diaphragm advances spring-loaded piston, permitting an infinite number of shaft positions through the stroke range. When pressure is relieved, spring returns piston to starting position.



Three-inch motor has adjustable stroke of 2⅛ in., 80 lbs thrust, requires 2 to 7 lbs starting pressure, and operates at line pressures to 22 psi. Four-inch motor has adjustable stroke of 3 in., 235 lbs thrust, requires 1 to 5 lbs starting pressure, and operates at pressures to 25 psi. Six-inch unit has adjustable stroke of 4⅛ in., starts at 3 to 5 lbs pressure, supplies 500 lbs thrust, and operates at pressures up to 30 psi. Housings are cast aluminum; all other parts, including shaft, are non-corrosive. Applications are for use on heating, ventilating, air conditioning and industrial units requiring a gradual push-pull control of levers or rods. **Powers Regulator Co.**, 3434 Oakton St., Skokie, Ill.

Circle 455 on page 19

### Temperature Controller

**has range of 1200 F**

Differential expansion type temperature controller operates in temperature ranges from sub-zero to 2000 F, including adjustable ranges as wide as 1200 degrees in

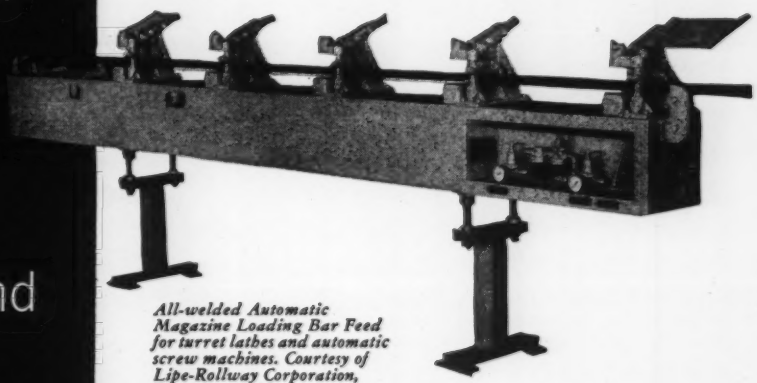
When steel is 3 times stronger than iron . . .

Has two and one-half times the rigidity . . .

Yet costs a third as much per pound . . .

**WHY aren't more of your products designed for welded steel?**

# NOW IT'S WELDED



*All-welded Automatic Magazine Loading Bar Feed for turret lathes and automatic screw machines. Courtesy of Lipe-Rollway Corporation, Syracuse, N. Y.*

## to save cost of manufacture . . . hold closer alignment

HOLDING precision alignment against the whip of bar stock was the problem. Welded steel design was the answer because:

**1. With steel's greater rigidity, an efficient, sturdy yet lightweight bar feed could be designed to withstand the impact of bar stock running at high spindle speeds.**

**2. Fabrication was easier since the design could be built from simple angles, channels, I beams and plate.**

**3. Overall cost was less than using gray iron construction.**

These benefits of welded steel can help you solve many of your design problems today and cut costs besides. Let Lincoln show you how. Write . . .

**THE LINCOLN ELECTRIC COMPANY**
Dept. 1116 Cleveland 17, Ohio

*Creating Lower Costs For Industry . . .*
*With Welded Design*



XUM

YOU WOULDN'T BUY
A HAT THAT'S TOO BIG!

SO WHY BUY A **Control** THAT'S THE WRONG SIZE?

**FURNAS**
MAGNETIC CONTROLS GIVE YOU
**CORRECT CAPACITY**
FOR THE JOB!

The many in-between sizes in the Furnas Electric starter line let you select the motor control that is best suited for your particular requirements—with no wasted capacity and expense. By matching the starter to the job you can *save up to 25%*. For proof, we invite your comparison of the Furnas Electric line of starters consisting of 9 sizes with the 5 sizes normally offered.

And you can *save up to 40%* in space by securing the correct size starters for the job, Furnas Electric produces more stock sizes of starters in the 1-100 hp range than other control manufacturers.

SERIES YD
SIZE 1

SERIES YE
SIZE 1¾

SERIES YF
SIZE 2

A15

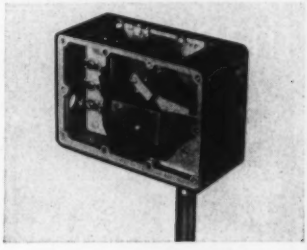
FURNAS

WRITE FOR BULLETIN 5530—1045 McKEE STREET, BATAVIA, ILLINOIS

Circle 573 on page 19

## New Parts

one instrument. Operation is by difference of expansion of two concentric tubes when exposed to heat. Resulting movement is multiplied through lever arrangement to operate one or more switches. Switch rating is 15 amp, 125-250



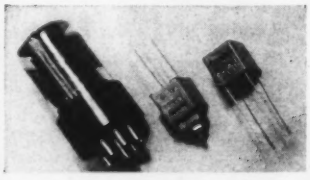
v ac, with higher ratings available. Case is weathertight, allowing outdoor installation. Temperature adjustments are made externally, and knob with pointer and locking set screw is available. Applications include accurate on-off temperature control of heating operations, processes, equipment, safety alarms and cut-outs, and combinations of control and alarm. Instruments have from one to three snap-action switches, depending upon requirements of installation. **Burling Instrument Co.**, 16 River Rd., Chatham, N. J.

*Circle 456 on page 19*

### Saturable Reactor

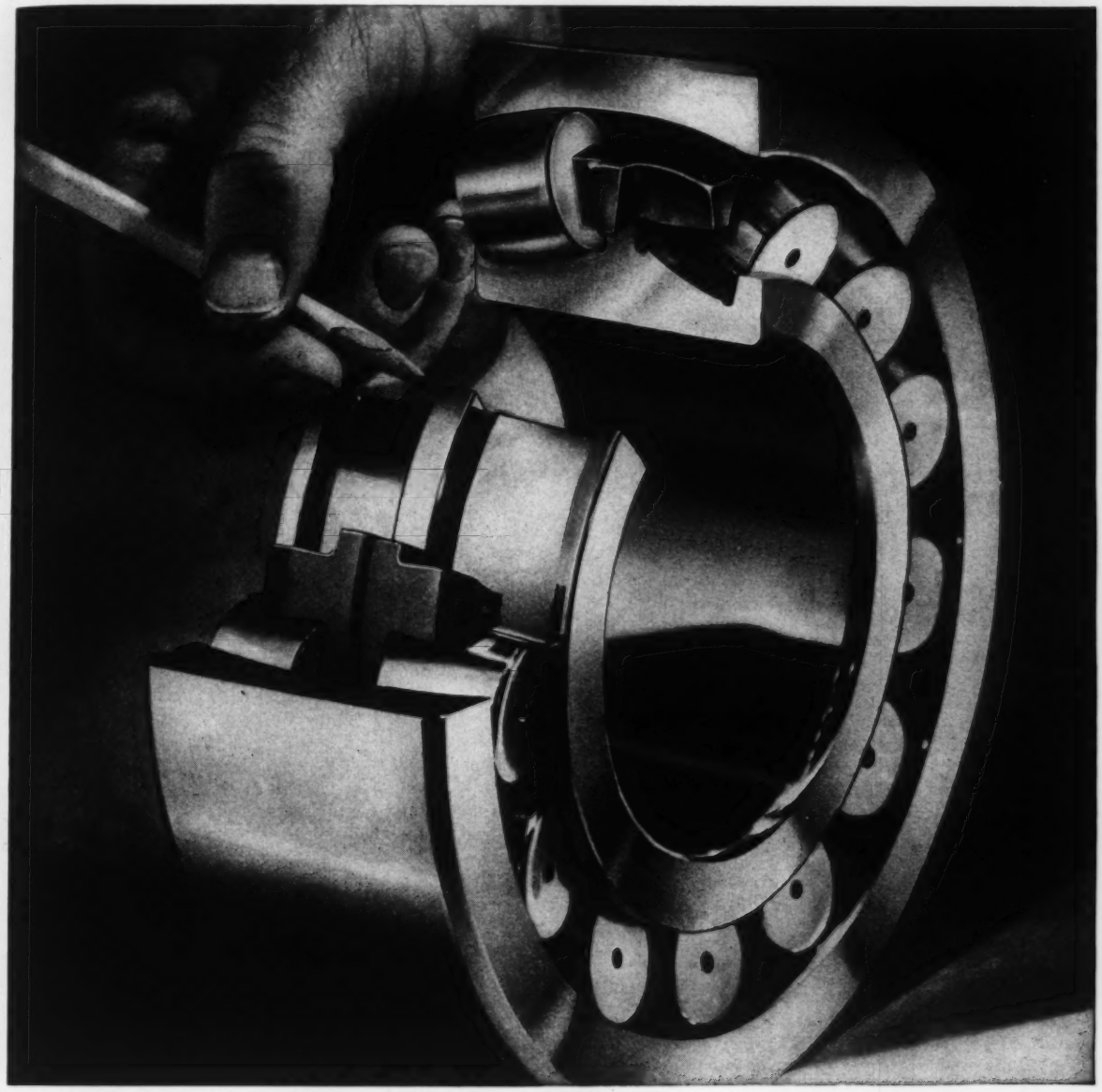
**replaces vacuum tubes for many functions**

Miniature saturable reactor is a simple coil wound on a magnetic core and encased in epoxy resin. Called a Ferristor, unit is reliable, light-weight, miniature in size, and



unaffected by humidity, temperature, shock, vibration, or accidental overload. Unit is only 9/16-in. square, but performs virtually all vacuum tube functions: input amplifier, gate, time base, decimal counting unit, coincidence amplifier, and control circuity. Ferristor is made in two classes, either for

# TORRINGTON SPHERICAL ROLLER BEARINGS



## "This flange guides the rollers to peak performance!"

The center flange on the inner raceway of the TORRINGTON Spherical Roller Bearing positions the rollers to handle thrust loads. This accurate positioning also assures radial stability of the rollers under heavy loads—even at continuous high speeds and under conditions of misalignment.

This superior design feature is only one of many advantages you get when you specify TORRINGTON. For example, you get the service of TORRINGTON'S experienced engineers, who will help you with design and maintenance problems—or design custom bearings for special applications.

For long, low-maintenance service in heavy-duty applications, order TORRINGTON Spherical Roller Bearings. They're available from stock with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
*District offices and distributors in principal cities of United States and Canada*

90th ANNIVERSARY 1865–1955

**TORRINGTON BEARINGS**

**Spherical Roller • Tapered Roller • Cylindrical Roller**
**Needle • Ball • Needle Rollers**



*Circle 574 on page 19*



XUM

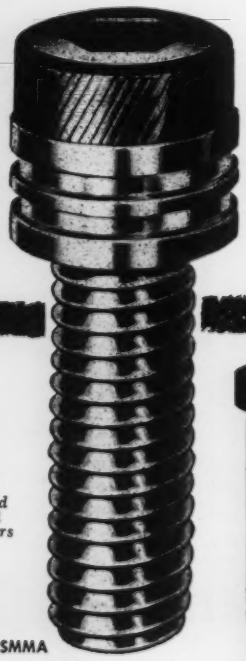
a complete line of

VIBRATION PROOF

"STANDARDS"!

Blue Devil SAF-LOK

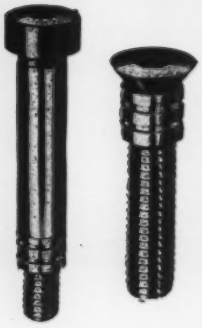
SOCKET CAP SCREWS



**BLUE DEVIL SAF-LOK CAP SCREWS** come in a complete line of sizes from #6 to 1" diameters, giving you a wide selection almost equal to what you'll find in ordinary socket cap screws. But these are different . . . remaining tight against any and all vibration. And only Blue Devil's got them!

*Sold only through authorized industrial distributors*

Member ASMMA



**SAF-LOK ALSO FOR SHOULDER SCREWS AND FLAT HEAD SOCKET SCREWS** . . . all three make an absolute seal against oil, water, gas and air as well as vibration,

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**SAFETY SOCKET SCREW COMPANY**

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Circle 575 on page 19

## New Parts

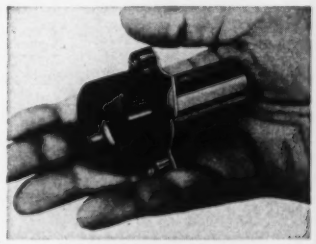
high-speed magnetic amplifier applications or for counting circuits. Units with adjustable magnets supply fixed magnetic bias; others, without magnets, are used with dc fixed bias. Designed to work with carriers in the 1 to 10 mc frequency range, magnetic-type Ferristors can be used in a wide variety of circuits. When engineered for ferro-resonant counter use, units combine with capacitors to form bistable circuits. Other circuity enables use as flip-flop or ring-type counter. **Beckman Instruments,** Berkeley Div., 2200 Wright Ave., Richmond, Calif.

Circle 457 on page 19

### Subminiature Blower

**weighs 5¼ oz.**

Subminiature blower, utilizing 1 in. diam motor, is designed for cooling airborne electronic equipment where space requirements are critical. Unit operates at 115 v, 400



cycles, and operates at 20,000 rpm. The 1/250-hp single-phase motor, with 0.22 mfd capacitor, delivers 8 cfm at 1-in. back pressure. Blower outlet is ⅞-in. wide and 17/32-in. high. Overall dimensions of blower housing are 2⅛ in. wide and 2 5/16 in. high. Weight is 5¼ oz. **Induction Motors Corp.,** 570 Main St., Westbury, L. I., N. Y.

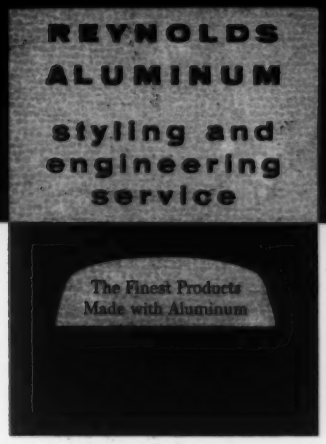
Circle 458 on page 19

### Limit Stops

**control number of revolutions of shaft**

Control of total number of shaft revolutions in either direction is provided by limit stop, which either halts shaft rotation by mechanical means or uses electrical switches to cut power at appropriate moments. Limit stops are of three basic types: wafer limit stop is used when load is comparatively

Circle 576 on page 19→




# DESIGNED IN ALUMINUM

## ...means greater product value

Products designed in aluminum are improved products—products that find increased sales acceptance. Strong, lightweight, rustproof aluminum offers many unusual design opportunities. To make the most of these opportunities it is often to your advantage to use the services of Reynolds Aluminum Designers. They will gladly work with you and your design consultants.

And when you decide on aluminum in preference to other materials usually only minor changes in your present fabrication methods and procedures are necessary. To make these simple changes it is frequently helpful to ask for the assistance of Reynolds Engineering Service.

The men in Reynolds design and engineering departments are aluminum experts—specially trained in aluminum to serve you most efficiently and profitably in your use of aluminum.

Much of what you'll want to know about aluminum is also available in book form. On the next page Reynolds handbooks and other informative materials are listed. These, too, are invaluable aids in getting the most from aluminum.

To have Reynolds designers and engineers work with you call the Reynolds office near you. It is listed under "Aluminum" in your classified telephone directory. Or write direct to Reynolds Metals Company, P. O. Box 1800—HW, Louisville 1, Ky.

**REYNOLDS ALUMINUM**

MORE INFORMATION ON NEXT PAGE

XUM

# Which of these will help you most?

A LIBRARY OF HANDBOOKS filled with important and useful information on aluminum design and fabrication. If your job is management, design or production, these books can be vital to you. Single copies of any or all of these are yours without cost when requested on your business letterhead.

**ALUMINUM DATA BOOK** – 160 tables give complete physical, chemical and mechanical properties; availability data, tolerances, definitions, fabrication information...220 pages.

**DESIGNING WITH ALUMINUM EXTRUSIONS** – Explains the basic principles for using extruded aluminum shapes most effectively . . . 138 pages.

**ALUMINUM STRUCTURAL DESIGN** – Shows how to design original structures with aluminum or convert present designs to aluminum . . . 130 pages.

**ALUMINUM FORMING** – Presents accepted practices for bending, forming and drawing aluminum . . . 152 pages.

**CASTING ALUMINUM** – Discusses casting design, methods and procedures, alloys, heat treating, machinery and finishing . . . 130 pages.

**FASTENING METHODS FOR ALUMINUM** – Offers information on mechanical joining and fastening methods, and the advantages of each . . . 136 pages.

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**MACHINING ALUMINUM ALLOYS** – Covers aluminum machining including automatic screw machining . . . 124 pages.

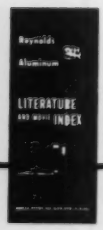
**HEAT TREATING ALUMINUM ALLOYS** – Explains the theory and procedures for heat treating aluminum alloys . . . 119 pages.

**WELDING ALUMINUM** – Gives complete data on the welding, brazing and soldering of aluminum . . . 186 pages.

**ALUMINUM POWDERS AND PASTES** – Describes types of powders and their uses in paints and coatings, pyrotechnics, processing, metallurgy and other applications . . . 84 pages.

## 16mm Sound-Color Films Available, too

1. **SHAPE OF THINGS TO COME** (extrusion design and application)
2. **TALE OF THE POWDERED PIG** (powders and pastes and their uses)
3. **PIGS AND PROGRESS** (aluminum from mine to finished products)
4. **THE CHEMISTRY OF ALUMINUM** (chemical aspects of aluminum production from bauxite mining to metallic aluminum)




**A COMPLETE INDEX**

of all Reynolds Technical Literature and Films on aluminum design and fabrication is also available. Write to Reynolds Metals Company, P.O. Box 1800-HW, Louisville 1, Kentucky.

**Instructors** in technical schools are also invited to take advantage of these educational aids. Write for details.

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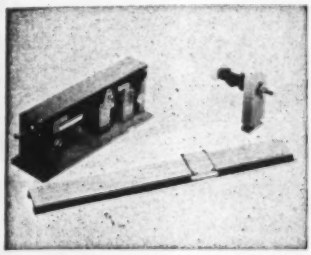
light and small number of turns are to be controlled; lead screw mechanical stop is used when a large number of turns are to be controlled, when load is heavy, or when severe shock is expected as shaft rotation is halted. Three lead-screw models are available, allowing 1 to 60, 1 to 120, and 1 to 180 turns. Lead screw electro-mechanical stop is used where large torques



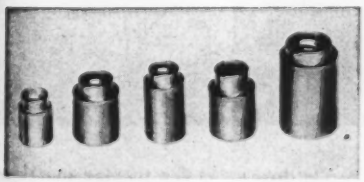
and inertias exist to protect assembly from sudden shock created as either limit is reached. This is accomplished by addition of limit switch to each limit stop to cut off power to driving unit just before either limit is fully reached. Associated terminals allow single-pole double-throw switches, rated at 15 amps at 50 v dc and 5 amps at 115 or 250 v ac, to be used normally open or normally closed. Unit allows from 1 to 100 turns, indicated by double scale calibrated in number of turns for each direction of axial movement. **Servo Corporation of America,** 20-20 Jericho Turnpike, New Hyde Park, N. Y.

*Circle 459 on page 19*

## Threaded Inserts

**for sheet material**

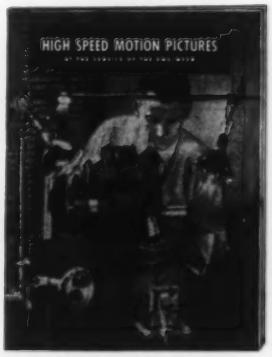
Rivet-type threaded inserts provide deep, full thread when installed in sheet materials and swaged or



silver soldered in position. Inserts are available tapped through or blind in standard Class 2 or 3 threads. Brass is standard mate-

(*Continued on Page* 144)

**Everyone working on design and performance problems of fast mechanical motion should have a copy of "High Speed Motion Pictures at the Service of the Engineer," a new booklet obtainable without charge from . . .**



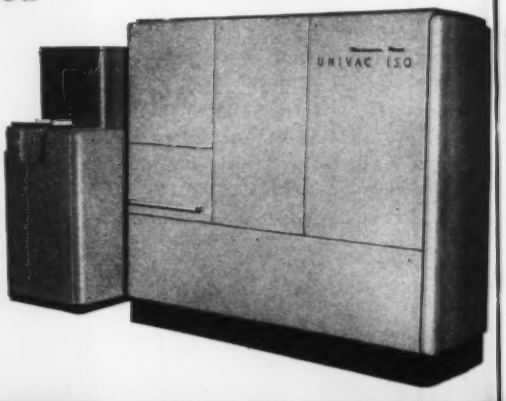

It tells about the new fast films for high speed movies and how various industries are using the Kodak High Speed Camera.

Kodak

*Circle 577 on page 19*

# SHORTER "THINK-TIME" FOR UNIVAC COMPUTER WITH WARNER ELECTRIC BRAKES AND CLUTCHES

## *New "SF" and "RF" units easily integrated into complex control circuit . . . simple design an important factor*

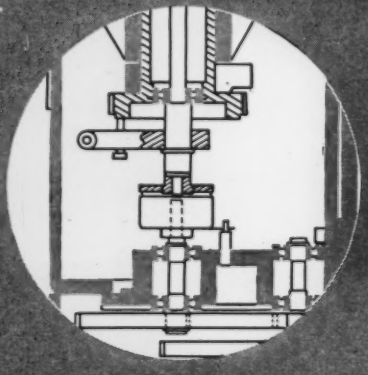



How can an electronic brain be made to think faster? Remington Rand Division of Sperry Rand Corporation found that Warner Electric Brakes and Clutches definitely speeded up the operation of the UNIVAC 60-120 Electronic Computer. Their simple, rugged design reduced maintenance as well—another important salability factor of complicated computing machines.

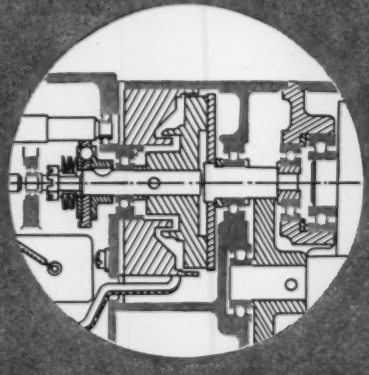
The UNIVAC 60-120 is a two-element automatic arithmetical computer. One element rapidly and continuously "reads" data from punched cards, transmits problems to the other—computing—element, and records the answers by punching them into the cards. The electric brakes and clutches control automatic start-stop cycle of the sensing and punching element between operations. Positive *20-millisecond stops* are accomplished by the RF-250 brake. Compact three-part design was important in the selection of the Warner units, which consist only of a magnetic field, an armature, and a replaceable face or rotor. Torque is easily controlled, and adjustment is never necessary.

Warner Electric Brakes and Clutches offer split-second operation and precise control for automatic cycling, indexing, positioning, starting, and stopping. Specify them on small machines, instruments, and servo drives. Give your machines the control advances your customers want. Now available in capacities ranging from 125 to 700 ft lb, maximum static torque ratings.

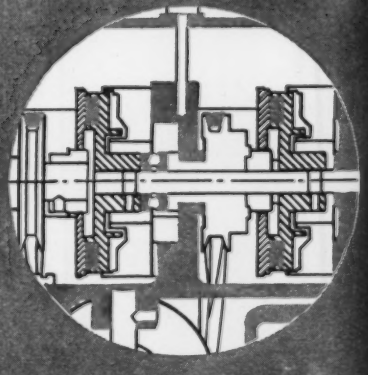
## EASILY SOLVE POWER PROBLEMS LIKE THESE



**Clutch-coupling for packaging machine**—Stationary field clutch serves as revolution-counting device for filling mechanism. Armature is keyed to spring-loaded counter arm that rotates through arc to contact limit switch. Rotor is keyed to shaft coupled through gearing to auger drive shaft. Auger drive clutch and counter clutch are energized simultaneously. When arm contacts switch, clutches are de-energized and brake is energized to stop auger drive shaft.

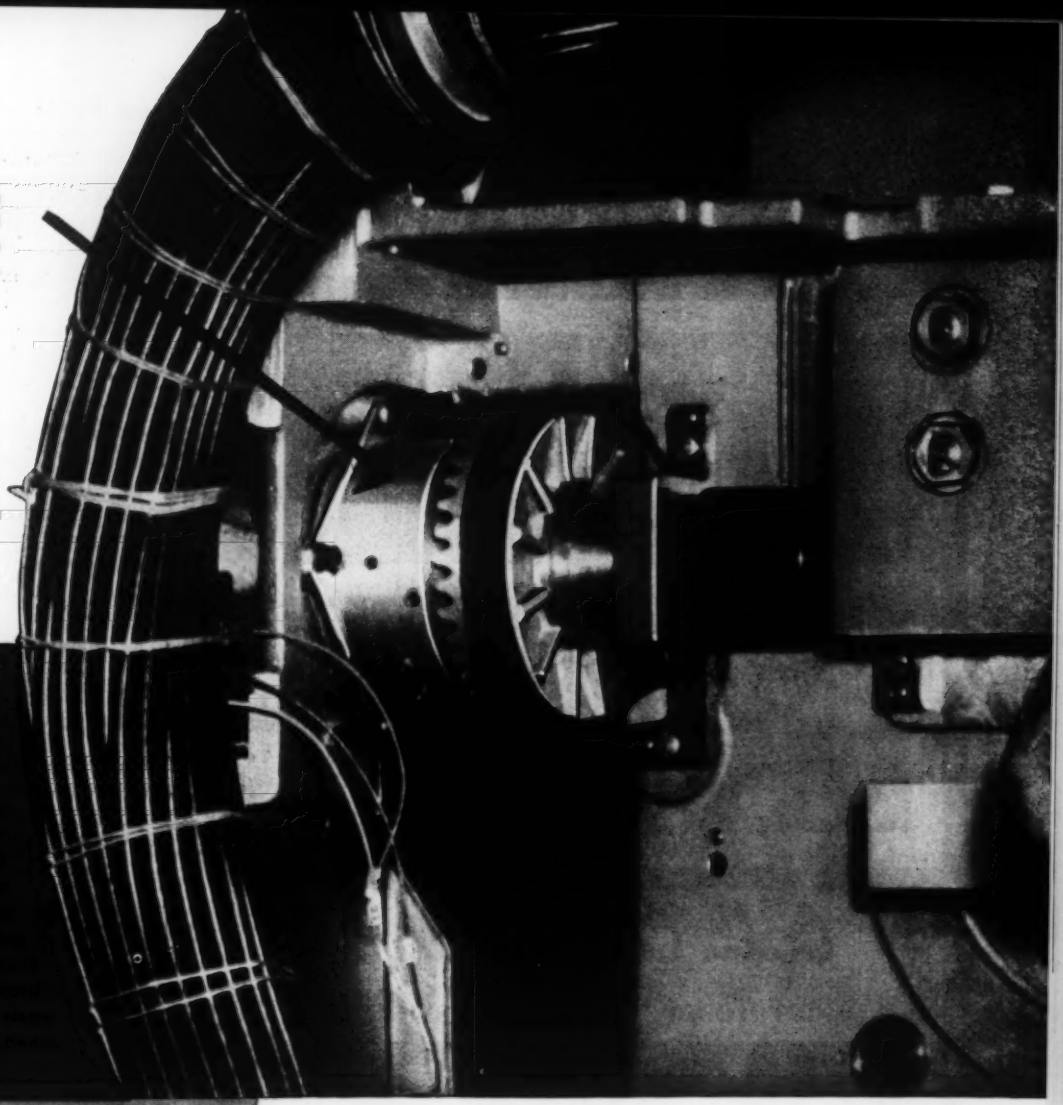


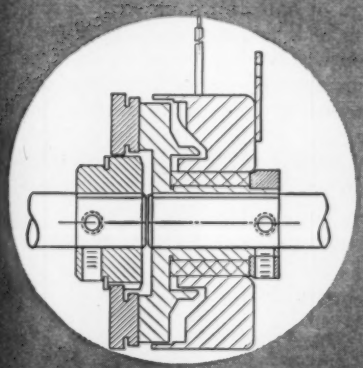
**Clutch for power steering unit** on the tail wheel of an airplane. Stationary field unit with the rotor keyed to shaft of drive motor, armature keyed to output shaft to rotary actuator. Energizing clutch couples drive motor to output shaft to rotary actuator which turns tail wheel in phase with the rudder. When wheel swivels in phase with the rudder, pilot can taxi plane in the direction he wants, regardless of mud or snow on landing strip.



**Clutch-coupling for tapping machine**—Two stationary field bearing-mounted clutches on lead screw give downfeed and reversing drive with continuous-running, nonreversing motor. For downfeed, armature is keyed to motor drive shaft, rotor mounted on lead screw drive shaft, field mounted on bracket. For reversing, armature is bearing-mounted to sheave driven by vee-belt from idler pulley, rotor keyed to lead screw drive shaft and field mounted on bracket.

Fast, smooth-functioning Warner Electric Brake and Clutch reduce time losses between steps and calculations.

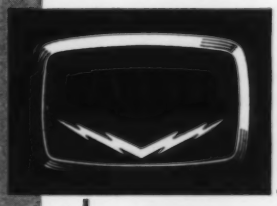




**Tipmaster clutch-coupling for office machine**—The field of SF-250 electric clutch is bearing-mounted to drive shaft, and the rotor is keyed to drive shaft. The armature transmits power to the driven shaft by means of a splined hub. Motor runs continuously and the clutch-coupling engages power to driven shaft until the limit switch opens the clutch circuit and de-energizes coil. Simple design cuts assembly time 60 per cent.

*Circle 578 on page 19*

Each cycle of the sensing and punching element is started and stopped electrically. A drive belt from a one-third horsepower electric motor is geared to the shaft on which the Warner units are mounted. The masses of connecting wires visible here give an idea of the extreme complication of the processes synchronized through Warner's fast starts and 20-*millisecond* stops.



*Beat competition with*

## ELECTRIC BRAKES AND CLUTCHES

**Warner Electric Brake & Clutch Co.**
**Dept. MD, Beloit, Wisconsin**

Please send me copy of your new Condensed Catalog No. 6212.

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Company _____

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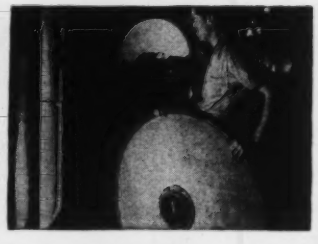

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**for accurate production, fast delivery**

Our engineers in the field and in the home office are ready to discuss your wire cloth fabrication problems at all times. They'll help you select weaves, mesh sizes and metals to meet your needs and draw up prints for your OK . . . or, they'll start the factory working from *your* prints. Whether orders are small or large, you're assured of strict adherence to specifications by close manufacturing supervision.

Your parts will be fabricated from any conceivable type of industrial wire cloth, selected from the complete Cambridge line. Specifications from the finest to the coarsest mesh in any metal or alloy are usually met from stock, assuring the speediest delivery. Individual loom operation and careful inspection provide the maximum in mesh size uniformity and mesh count accuracy.

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You can get immediate delivery on large or small orders for the most frequently used types of cloth. If your needs are not in stock, we'll schedule our looms to get your material to you without delay.

**LET US QUOTE on your next order for fabricated parts or wire cloth in bulk. Call your Cambridge FIELD ENGINEER—he's listed under "Wire Cloth" in your classified telephone book. OR, write direct for FREE CATALOG and stock list giving full range of wire cloth available, description of facilities and metallurgical data.**

**The Cambridge Wire Cloth Co.**

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Department N, Cambridge 10, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

Circle 579 on page 19


## New Parts

(*Continued from Page* 141)

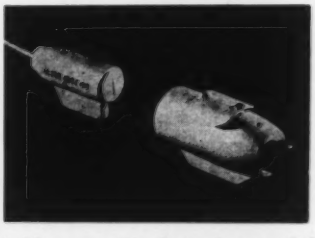
rial, cadmium plated if required. Thread sizes are No. 2 through No. 10. Five shank sizes permit installation in material ranging in thickness from 1/32-in. to 5/32-in. Diameter range is 5/32-in. to 5/16-in.; projecting lengths are 0.218 to 0.500-in. for blind hole, 0.125 to 0.312-in. for through hole. Applications are for use on transformer and capacitor cans and as stand-offs for sheet laminated plastic in electronic work. **Standard Insert Co.**, 12270 Montague St., Pacoima, Calif.

Circle 460 on page 19

## Photoelectric Control

**has narrow beam for precision detection**

Small photoelectric control is adaptable for counting, sorting, color matching, level detection, edge register, safety, automatic shutoff and alarm, or smoke and turbidity con-



trol. Narrow slit of receiver and design of optical system enables control of a machine component position within close limits. Slit can be rotated to suit conditions, and can operate in horizontal, vertical, or angular position. Unit lends itself to readout with optical shaft position indicator. **Mason Instrument Co.**, 29 Elm Ave., Mt. Vernon, N. Y.

Circle 461 on page 19

## Adjustable-Speed Drives

**give 0 to 2400 rpm from remote control**

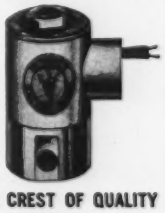
Adjustable-speed drives in both ¼ and ½-hp models are available with geared or ungeared motors. Ungeared motor delivers constant torque at speeds infinitely adjustable from 0 to 2400 rpm. Geared motors deliver speeds of 0 to 150 rpm in ¼-hp size, and 0 to 600 rpm in ½-hp size. Compact con-

# OVER 100,000 VARIATIONS

It's a fact . . . Skinner V5 Valves are obtainable in more than 100,000 variations! The unique design of these rugged, low-cost valves makes them easily adaptable to countless applications throughout industry. They're built to withstand high voltages, extremes of temperature and constant energizing over a period of years, through millions of cycles. A vast variety of port locations and flow adjustments enables you to make valves conform to your equipment, rather than vice versa.

Skinner Valves are available with UL-approved Explosion-Proof construction, and with "Quick Exhaust" for extra-fast cylinder return.

If you have a solenoid valve problem, by all means call in a specially trained Skinner resident engineer. There's no obligation, and chances are you'll find your problem solved in a trice. *Write today for Skinner's new solenoid valve catalog.*



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SOLENOID VALVES

WORLD-WIDE REPRESENTATION

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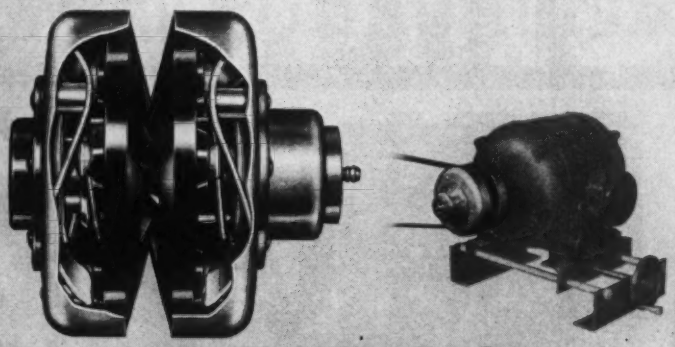
New Britain, Conn.



Circle 580 on page 19

*striving for* **SIMPLICITY?**



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Design-wise, HI-LO automatic variable speed pulleys help you reduce complex design problems. Functionally, they're first choice of many design engineers for a wide range of applications. The simple, positive action of cam followers on cams is the mechanical action that takes place in maintaining the pitch diameter setting regardless of load—an exclusive feature of HI-LO pulleys. Springs in HI-LO pulleys are not driving members as in most spring-loaded pulleys, but serve primarily to keep the pulley faces in contact with the belt.

For *FREE* technical manuals with diagrams, descriptions of applications and other power transmission data, write:

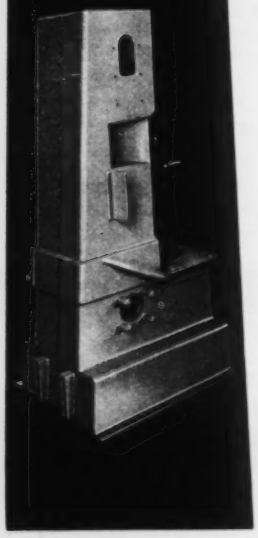
*Equipment Engineering Company*

2855 Columbus Ave., Minneapolis, Minnesota

Circle 581 on page 19

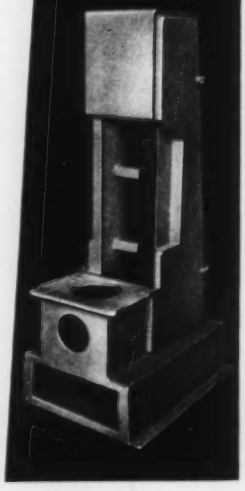
**LITTLEFORD**

the design engineer's best friend!



Design engineers like Littleford weldments and sub-assemblies. Littleford doesn't ask you to compromise with good design.

You get the weldment exactly as you want it, right and right on time. Write and put your design problem up to our fabricating specialists today!

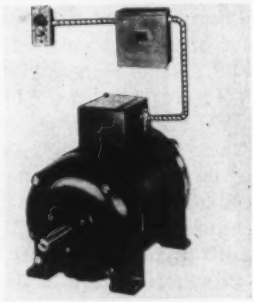


LITTLEFORD BROS., inc.
Dept. LB-199,
424 E. Pearl St.,
Cincinnati 2, Ohio

Circle 582 on page 19


## New Parts

trol head utilizes low voltage circuit and may be remote from either motor or rectifier cabinet. All resistors and condensers are



sealed with epoxy resin in a single plug-in assembly. Models are available with tachometer control which maintains speed within one per cent, or with reversing control and dynamic braking. **Servo-Tec Products Co. Inc.,** 1086 Goffle Rd., Hawthorne, N. J.

Circle 462 on page 19

### Silicone O-Rings

**are made in molds for organic rubber**

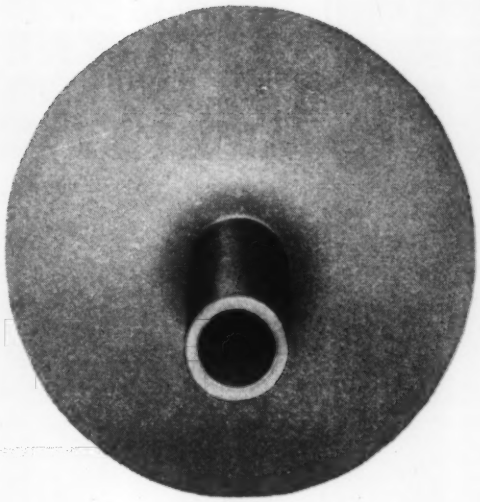
Silicone rubber O-ring seals are available from standard AN and MS production molds, designed for organic rubber, by using Class 300 silicone compound which has same shrinkage rate as organic rubber. Features of the silicone compound are the elimination of necessity for special tooling and improved uniformity of product, with close conformity to standard dimensions and decrease of loss due to rejections. **General Electric Co.,** Silicone Products Dept., Waterford, N. Y.

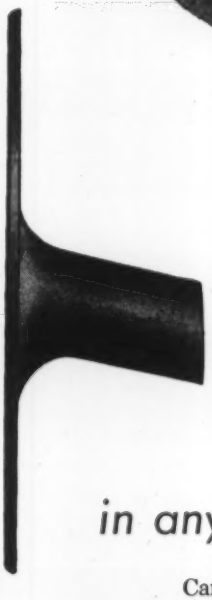
Circle 463 on page 19

### Miniature Motors

**available with either induction or hysteresis rotor**

Compact, precision miniature motors — designed for applications where size, weight, and high performance are governing factors— meet all applicable military environmental specifications. Motors are available in three-phase two-pole or four-pole models, and two-phase two-pole or six-pole models. Both three-phase and two-phase motors can be operated on single-phase with a phasing capac-





from Crucible

# Aircraft Quality STAINLESS INVESTMENT CASTINGS

in any shape or grade . . .

Can your product benefit from the important features shown in these Crucible Accumet® precision investment stainless castings? They are tube supports for jet aircraft engine assemblies, but the characteristics they illustrate are just as vital to thousands of other applications.

**THIN WALLS** — Accurately produced by the Accumet casting process, they are impossible to make in sand or shell mold castings — very difficult to forge.

**BLIND HOLES** — like this one, are impossible to forge, expensive to machine, and very difficult to sand cast . . . but they can be held to close tolerances by Accumet casting.

**CORING** — Deep or intricate cores — prohibitively costly to machine — can be economically produced by the Accumet process.

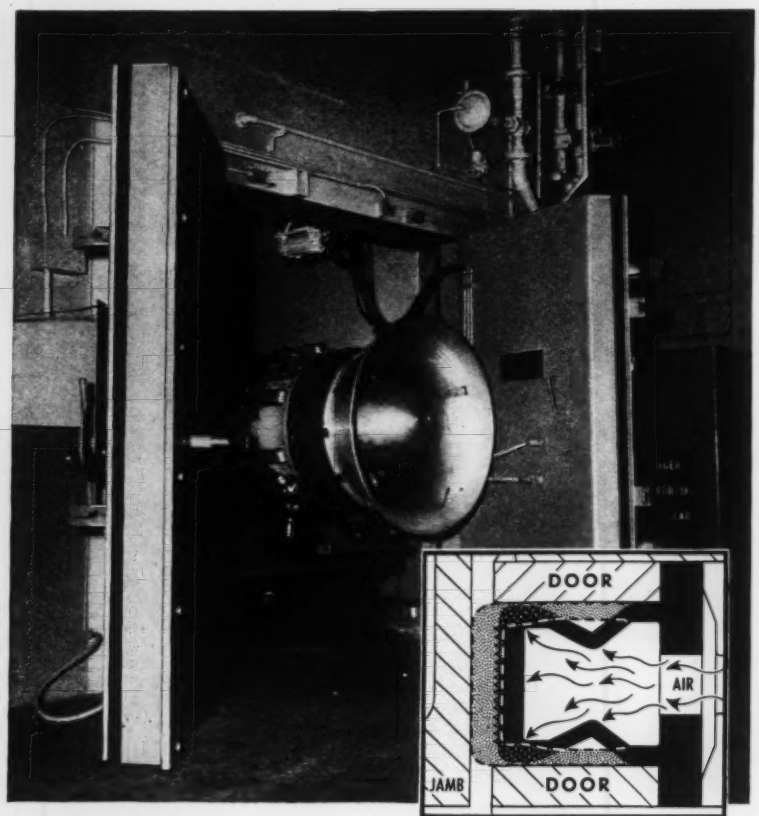
**ODD SHAPED PARTS** — difficult to chuck and machine, are economical when they're Accumet castings.

Next time your designs call for parts with intricate shapes . . . close tolerances . . . fine finish . . . high quality and uniformity, make them Crucible Accumet castings. They are available in any grade of steel or high alloy your product calls for. Let a Crucible engineer give you all the facts about how Accumet castings can save you time and money. *Crucible Steel Company of America, The Oliver Building, Mellon Square, Pittsburgh 22, Pa.*

Write for a free copy of the informative folder "Accumet Castings".

**CRUCIBLE** first name in special purpose steels

**Crucible Steel Company of America**




Dotted area shows gasket inflated

Photo courtesy General Electric Co.

## Pneumatic Rubber *Door Seal* Muffles Test Cell Noises

To more effectively suppress noise, General Electric jet engine test cells are equipped with a unique pneumatic rubber door seal. Mounted on door perimeter, this seal is designed to expand proportionally and insure a perfect seal over its entire sealing surface *including the corners*. Not only does this gasket dampen the noise but it permits more accurate testing through quieter working conditions.

Continental engineers developed this pneumatic gasket for this and similar applications. Compounded of special flex-resistant rubber, this versatile gasket can be operated with intermittent flexing cycle *or* as a continuous seal—can be adapted to various other types of doors—for *either* pressure or vacuum rooms.

The design of this gasket typifies the engineering skill offered by Continental. When you need "engineered rubber parts"—molded or extruded—enlist the service of specialists—consult Continental.

**Engineering Catalog.**

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

*Another achievement in* **RUBBER**

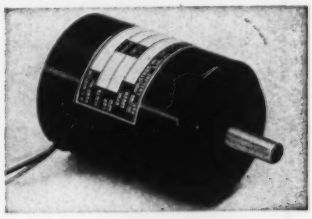
*engineered by* **CONTINENTAL**

CONTINENTAL RUBBER WORKS • 1984 LIBERTY ST. • ERIE 6 • PENNSYLVANIA

Circle 584 on page 19


## New Parts

itor. Units are available with induction rotor for high output, or hysteresis rotor for operation at synchronous speeds. Characteris-



tics of motors can be readily modified to cover wide range of application requirements, such as high starting torque or improved starting at low temperatures. Motors are reversible and may be furnished with integral planetary gear reducers. Eight standard motors have speed range from 8000 to 24,000 rpm, 115 and 200 v ac, 2 or 3 phase, 400 cycles. Weight is 11.5 oz; size is 2¼ in. long by 1⅝ in. diam. Shft size is ¼-in. **Globe Industries Inc.**, 1784 Stanley Ave., Dayton 4, Ohio.

Circle 464 on page 19

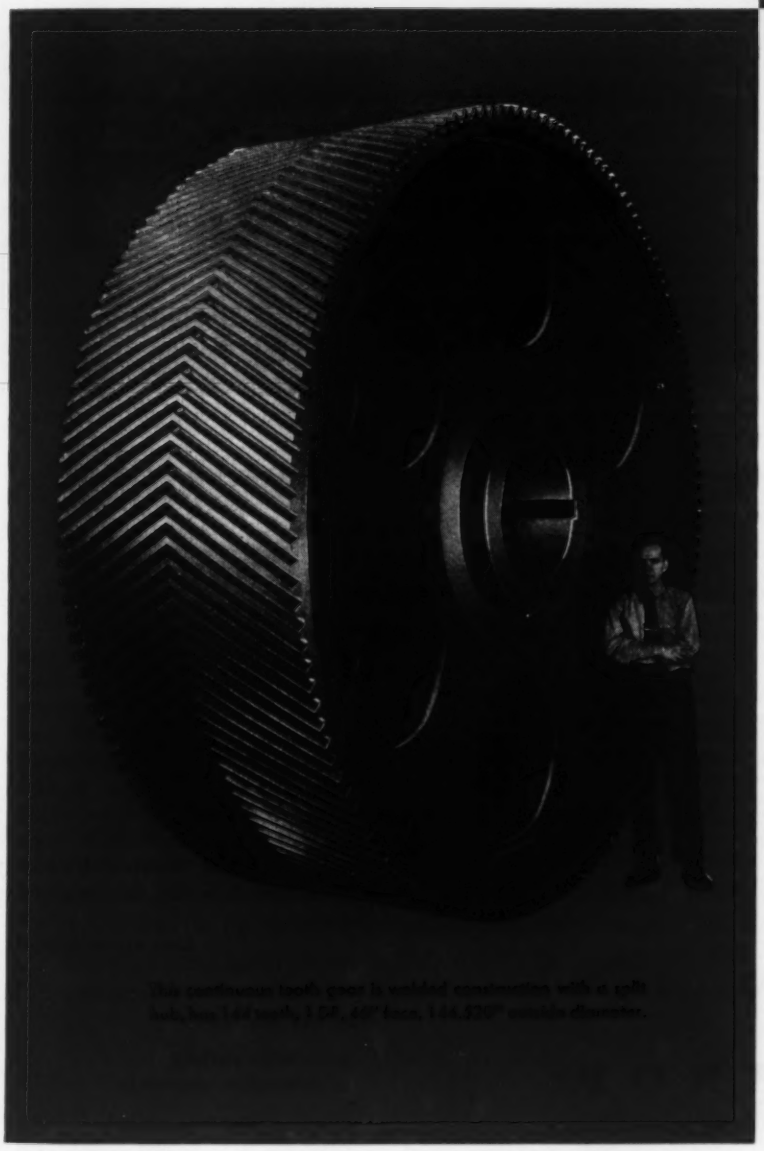
### Solenoid Pilot Valve

**controls remote valve or small cylinder**

Small solenoid pilot valve for handling air, vacuum, oil, water, or inert gases, is available in both 2 and 3-way types. Valve is designed to control remote operated valve, or for direct control of small cylinder or similar device, where accurate control and quick response is required. Capacities range up to 23.8 cfm air or 3.8 gpm hydraulic fluid at cycle speeds to 600 per minute. Solenoid enclosure is dust and moisture-proof. Normal service life exceeds 25-million cycles. Both plunger and spring, the only moving parts, are stainless steel; and hycar seats and O-ring seals resist oxidation and abrasive wear. Air passing around plunger cleans and lubricates it and cools the coil. Valve is available with or without integral junction box large enough for 6 in. taped pigtail leads. Removal of solenoid cover, fitted with captive screws, renders valve inoperative. Cylinder ports are ¼-in. NPT; conduit connections are ½-

# BACKBONE

## comes in any size up to 23′ for any power capacity



Farrel continuous-tooth herringbone gears are made in a complete range of sizes from ¼ inch to 23 feet diameter, ¼ to 60 inch face, 24 DP to 0.75 DP, for any power capacity and any application.

The backbone in Farrel herringbone gears, formed by the meeting of the two helices without a center groove, puts the entire face width of the gear to work for you. This pays off in extra strength and greater load and shock capacity—ideal for heavy-duty applications.

Farrel can also supply straight tooth (spur) gears, single helical gears and internal gears in a wide range of sizes—all precision-generated on Farrel-Sykes machines.

Farrel engineers are available for consultation on your gear problems.

•

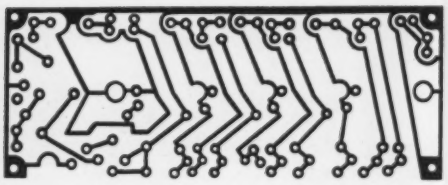
**FARREL-BIRMINGHAM COMPANY, INC.**
ANSONIA, CONNECTICUT

*Plants:* Ansonia and Derby, Conn., Buffalo and Rochester, N. Y.

*Sales Offices:* Ansonia, Buffalo, Boston, Akron, Detroit, Chicago, Minneapolis, Fayetteville (N. C.), Los Angeles, Salt Lake City, Tulsa, Houston

FB-1092

*Farrel-Birmingham* ®



# ELECTRICAL ENGINEERS

If you have had engineering experience in any of the categories shown below, Northrop Aircraft has an attractive position for you, with many benefits. Important among them are high compensation, challenging assignments, steady advancement, recognition of initiative and ability, and continued interest in your progress. Many outstanding engineering positions are offered, as follows:

**ELECTRICAL GROUP,** which is responsible for the design of such things as power generation and distribution systems, rectifiers and power converters, and auxiliary systems as applied to manned aircraft, guided missiles and ground support equipment.

**COMMUNICATIONS AND NAVIGATION GROUP,** which is responsible for the design of C/N systems in manned aircraft and installation of guidance systems in missiles.

**FIRE CONTROL RADAR GROUP,** which is responsible for the installation and application of the most advanced type of fire control systems in fighter-interceptor aircraft. The work covers the installation of the equipment and associated wiring; continuing liaison with equipment manufacturers; preparation of system analysis and reports; and follow-up of system performance in the field as aircraft become operational.

**INSTRUMENT GROUP,** which is responsible for the design of instrument systems for manned aircraft and the installation of flight test instrumentation for guided missiles.

There are also opportunities for draftsmen with either electrical or mechanical experience.

At Northrop Aircraft you will be with a company that has pioneered for seventeen years in missile research and development. Here you can apply your skill and ability on top level projects such as Northrop's new supersonic trainer airplane, Snark SM-62 intercontinental missile, and constantly new projects. And you'll be located in Northrop's soon to be completed multi-million-dollar engineering and science building, today's finest in comfortable surroundings and newest scientific equipment.

If you qualify for any of these representative positions, we invite you to contact the Manager of Engineering Industrial Relations, Northrop Aircraft, Inc., ORegon 8-9111, Extension 1893, or write to: 1015 East Broadway, Department 4600- F, Hawthorne, California.

**NORTHROP**

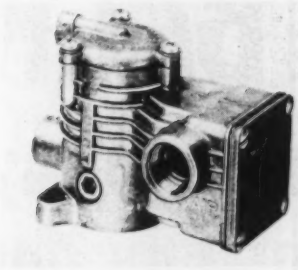
NORTHROP AIRCRAFT, INC., HAWTHORNE, CALIFORNIA

Producers of Scorpion F-89 Interceptors and Snark SM-62 Intercontinental Missiles

5-A-87

*Circle 586 on page 19*


## New Parts



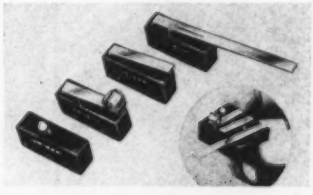
in. NPT. Valve is available for direct pipe connection, with subbase, or drilled to specification. Coils are supplied for 3 to 300 v dc, 6 to 550 v ac, 25 to 60 cycles. Maximum coil current consumption is 10 watts. **Valvair Corp.,** 454 Morgan Ave., Akron 11, Ohio.

*Circle 465 on page 19*

### Subminiature Switch

**snap-action unit is ¼-in. wide**

Subminiature switch features actuators requiring no adjustment which are integral with the switch body. Small size and flat, unobstructed sides of switch permit



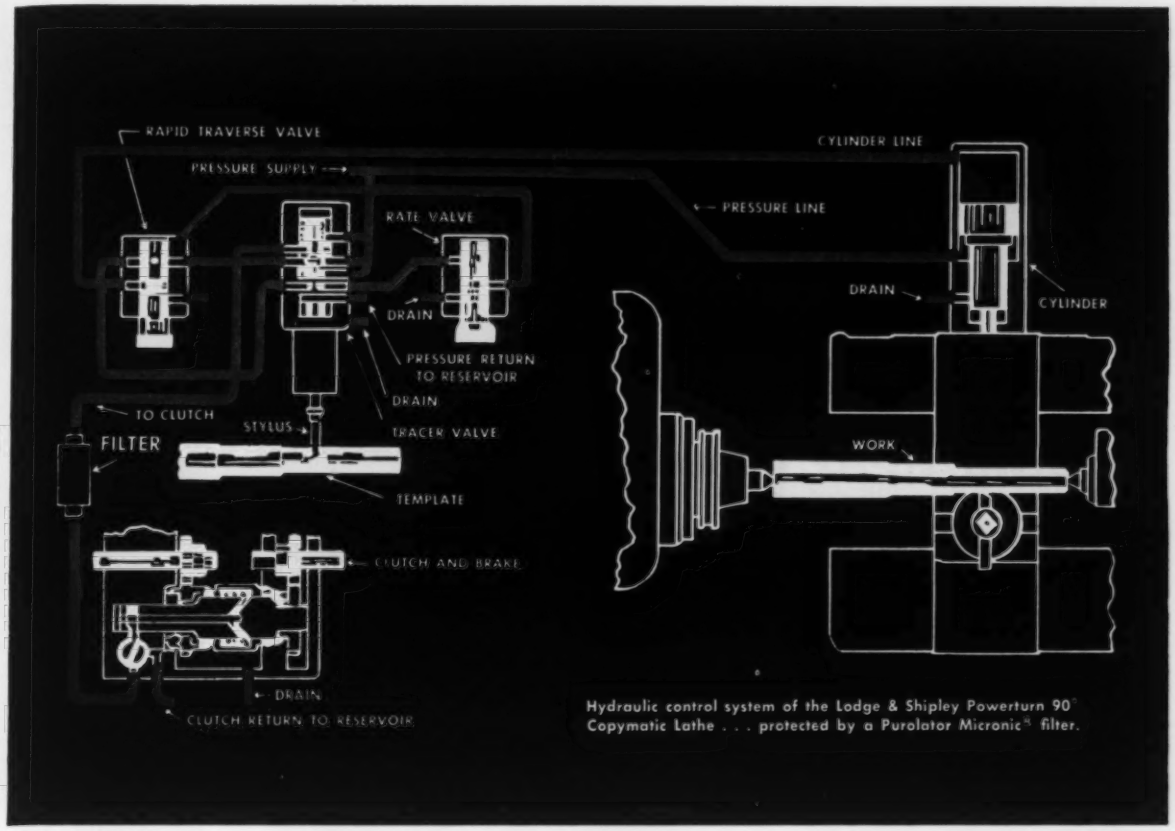
ganging of four switches per inch in miniaturized apparatus. Four types of actuators are available: pin-type, leaf, long-leaf, and leaf-roller types. Single-pole double-throw switch is rated at 5 amp 125/250 v ac. Size is ¼-in. thick, 25/32-in. long, and 9/16-in. high. **W. L. Maxson Corp.,** Unimax Switch Div., Ives Rd., Wallingford, Conn.

*Circle 466 on page 19*

### Contact Adhesive

**joins wide variety of dissimilar materials**

Contact adhesive, called Pliotac, gives good bond strength, excellent tack, low level dry film odor, and permanent flexibility after application. Adhesive is a light-colored material with good color retention,




Hydraulic control system of the Lodge & Shipley Powerturn 90° Copymatic Lathe . . . protected by a Purolator Micronic® filter.

# Designed for highly accurate control ...fully protected by Purolator Filtration

On a very successful automatic duplicating lathe, this hydraulic control system makes possible both quick, simple operation and a high degree of sensitivity and accuracy. Reliable and uninterrupted operation of a system like this is dependent upon freedom from contaminants. That's why the Lodge and Shipley Company, its manufacturer, made Purolator Micronic® filters an integral part of their hydraulic system.

Purolator engineers recommended a standard filter from their stock of over 2000 models. It more than met the system's special requirements.

The controlled porosity of Purolator's Micronic element evenly filters out contaminant particles as small as .000039 inch. And because it's made of plastic-impregnated cellulose, the Micronic element is not affected by high temperatures, water, or oil.

**PUROLATOR**

**PRODUCTS, INC.**

"FIRST IN THE FIELD OF FILTERING"

Rahway, New Jersey and Toronto, Ontario, Canada

**Filtering information for product designers is available in our 32 page "Filtration Manual for Product Designers". Just enclose 25¢ to cover postage and handling. Address Dept. P5-108**

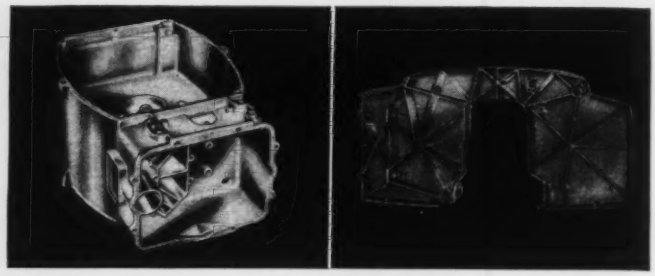


Circle 587 on page 19

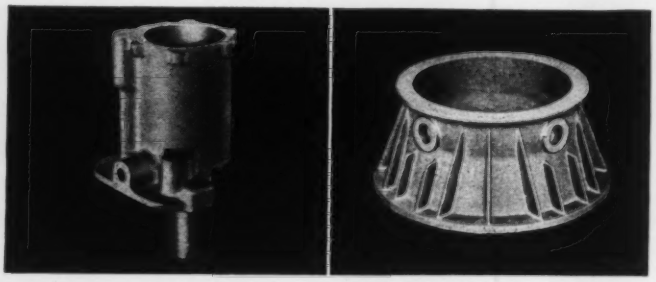


XUM

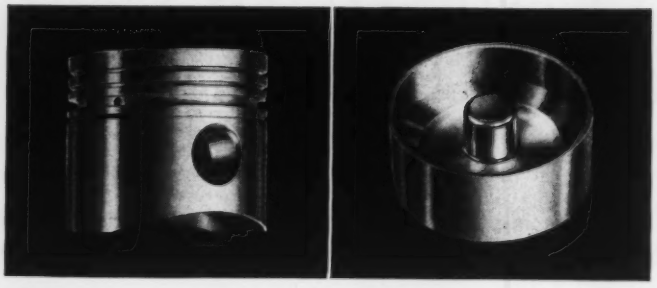
for die castings



...permanent mold castings



...impact extrusions



Regardless of your product, if you use castings or impact extrusions, Thompson's experienced and creative engineers can show you where and how to simplify your operations and save on costs. Let us quote now on your plans. Just write, wire or phone Dept. MD10, Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio, HEnderson 1-6765.

You can count on

Thompson Products

LIGHT METALS DIVISION

2269 Ashland Road • Cleveland 3, Ohio

Circle 588 on page 19

## New Parts

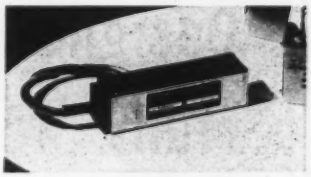
contains 25 per cent solids, and is water and moisture resistant. Application is by brush or trowel-spreading, or, when thinned with toluene, by spraying. Designed to meet a variety of bonding conditions where large areas are involved, adhesive is recommended for joining any combination of plywood, plastic, fiberglass, foam rubber, natural-fiber textiles, metals, plaster, concrete, or ceramics. Adhesive is applied to both surfaces and given an open-dry time before coated surfaces are placed together under sufficient pressure to assure bond. Coverage is 100 to 200 square feet per gallon. **Goodyear Tire and Rubber Co.**, Chemical Div., Coatings Dept., Akron 16, Ohio.

Circle 467 on page 19

### Electrical Relay

**has sealed switch**

Relay has hermetically and individually sealed contacts to eliminate possibility of contact contamination. Magnetically operated, hermetically sealed switching element



is isolated from all other parts of unit. Available with coils for use at 6, 12, 24, or 48 v dc, relay switch contacts are normally-open or normally-closed. Rating is 0.5 amp inductive or resistive at 28 v dc. **Revere Corp. of America,** Wallingford, Conn.

Circle 468 on page 19

### Centrifugal Fan

**in capacities to 1 million cfm**

Airfoil centrifugal fans for heavy-duty industrial applications are available with single and double inlet construction in a large number of sizes for volumes up to 1-million cfm. Design of airfoil blade plus streamlined inlets, wheel rims, and housing, contribute to mechanical efficiency of over 92 per cent and static efficiency of 88.5 per

# ORANGE *Cage Type* NEEDLE BEARINGS

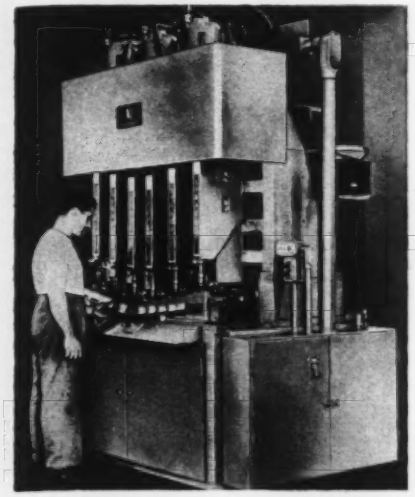
## handle both reciprocating and rotating action in this Stud Driving Machine

•

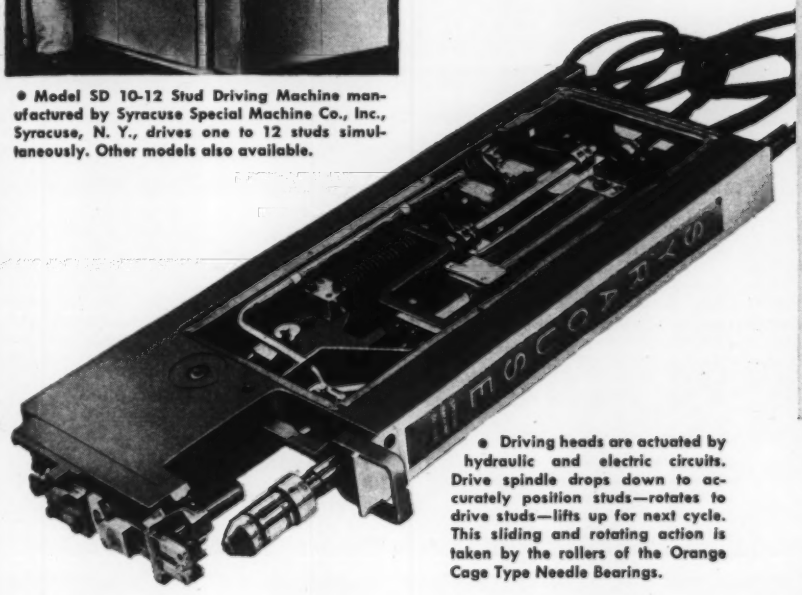
## *"Long life and smooth operation"*

**reports**

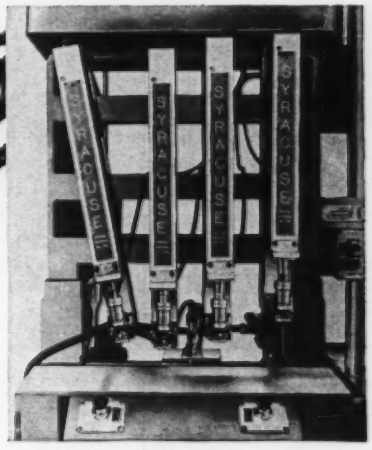
**Syracuse Special Machine Company, Inc.**



• Model SD 10-12 Stud Driving Machine manufactured by Syracuse Special Machine Co., Inc., Syracuse, N. Y., drives one to 12 studs simultaneously. Other models also available.



• Driving heads are actuated by hydraulic and electric circuits. Drive spindle drops down to accurately position studs—rotates to drive studs—lifts up for next cycle. This sliding and rotating action is taken by the rollers of the Orange Cage Type Needle Bearings.

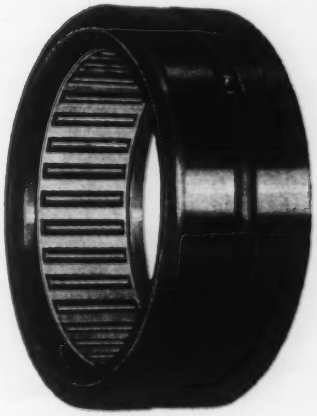



• Driving heads may be angled up to 30° from vertical.

This unusual application emphasizes the value of the Orange cage design which keeps rollers in alignment to prevent skewing under all operating conditions—assuring true running in any position, whether horizontal, vertical, tilted or on overhung mountings.

Orange Cage Type Needle Bearings provide high load capacity in small space—run evenly and quietly—give long service.

Orange Cage Type Needle Bearings are compact, heavy-duty, precision bearings available in stock sizes from ½" to 8" shaft dia., interchangeable with all standard needle bearings. Write for Engineering Manual M-56.



**ORANGE ROLLER BEARINGS**

**ORANGE ROLLER BEARING CO., Inc.**
**556 Main Street, Orange, N. J.**

**Needle Bearings — Staggered Roller Bearings**
**Journal Roller Bearings — Thrust Roller Bearings**
**Cam Followers**

Do you need
PRECISION
anti-friction
BEARINGS

for
HIGH-TEMPERATURE SERVICE to 500° F — 1000° F — 1500° F ?

for
RESISTANCE TO CORROSION by Acids — Caustics — Salts ?

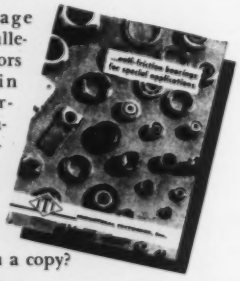
for
RESISTANCE TO ABRASION by wet or dry grit, silt, etc. ?

with
NON-MAGNETIC PROPERTIES, electrical conductance, etc. ?

with
SPECIAL SHAPES AND SIZES, low torque, ultra precision . . ?

WE MAKE bearings to these and other special requirements, in experimental and production quantities. We've been doing that for years, for well-known firms. So if *you* need special anti-friction bearings for *any* application, let's talk it over.

FREE 32-page Bearings Bulletin tells factors involved in special bearing applications — describes our work in this field.



May we send you a copy?

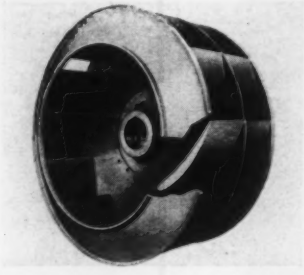
**INDUSTRIAL TECTONICS, Inc.**
3691 Jackson Rd., Ann Arbor, Michigan
5012 E. Washington Blvd.
Los Angeles 22, Calif.

PRECISION BALLS AND SPECIAL ANTI-FRICTION BEARINGS

Circle 590 on page 19

## New Parts

cent. Fan is of welded construction; blades are reinforced for additional strength; and hub is cast iron, riveted to hub-plate and bored

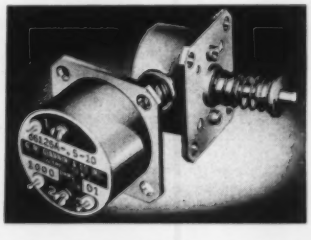


to close tolerance. Anti-friction or self-aligning sleeve-bearings are furnished as specified. Volume control is by means of inlet vanes, outlet damper, or adjustable speed drive. **American Blower Corp.**, Detroit 32, Mich.

Circle 469 on page 19

### Pancake Potentiometer

**has long stroke in small unit**



Miniature spring-loaded linear-motion precision potentiometer has less than 1-in. of body length for full 0.5-in. stroke. Strokes from 0.1 to 0.5 in. are available in resistance ranges of 1000 and 2000 ohms with linearity of ±1 per cent and resolution of 0.0012 in. Applications are in laboratory equipment, industrial control systems, and servo follow-up on linear actuators. **G. M. Giannini & Co. Inc.**, 918 E. Green St., Pasadena 1, Calif.

Circle 470 on page 19

### Micro Cap Screws

**from micro sizes to 5/8-in.**

Micro size socket cap and set screws are made of heat-treated alloy steel and 18-8 stainless steel. Stainless steel screws are not heat-

**Can 0.0005 inch precision strip simplify your product design?**

From 0.0005 in. to 0.040 in. thick and 0.090 to 6 in. wide, these alloys are available as special-tolerance strip:

**Beryllium Copper**
**Phosphor Bronze**
**Nickel Silver**
**Brass**
**Chromium Copper**
**Stainless 17-7PH**
**Invar**
**Magnetic: High Nickel**

Some immediately available. Others rolled to order in 2 to 21 days. Can be supplied in coils or straight lengths with slit or filed edges—also cadmium plated.

Write for Bulletin 7 TODAY.

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Los Angeles — *KRUSEN WIRE & STEEL CO.*

Circle 591 on page 19

E. B. Smiley, Metallurgist for Illinois Gear & Machine Co., looks over setup of large, heavy duty bevel gear made from molybdenum alloy steel casting. This gear has been rough turned, rough cut and heat treated to 269 to 302 Brinell before finish cutting.

# For Strength, Hardness and Machinability gear maker recommends Molybdenum Alloy Steels

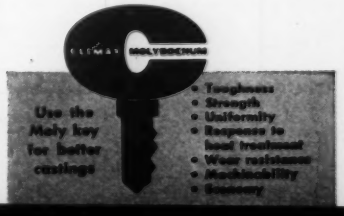
**"All of our gears are made to customer specifications, and in many cases these include the use of molybdenum steels," says Mr. Smiley, metallurgist for Illinois Gear & Machine Co. "When our customers specify heat-treated gears of plain carbon steel," Mr. Smiley continues, "we often recommend that they change to 4140 alloy containing molybdenum to achieve high strength and hardenability with good machinability."**

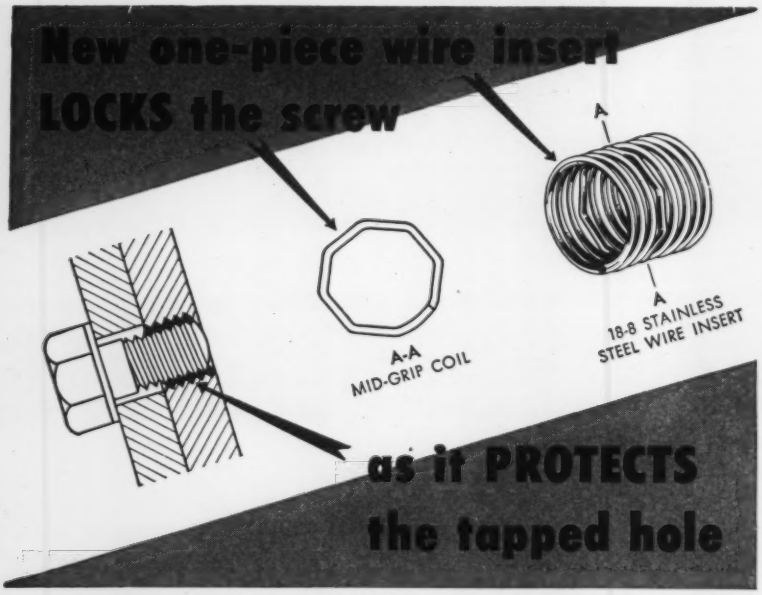
Moly steels offer gear users many advantages over carbon steel. Their greater strength and toughness permit the use of smaller weight-saving gears to transmit a given amount of power. Reduced weight and size of gear housings and other components add to the economy of moly steels. And their higher endurance is an important safety factor.

The properties of moly steels are discussed in a new booklet "Moly Steels for Cast Gears". Full technical assistance is also yours for the asking. Write Climax Molybdenum Co., Dept. 11, New York 36, N. Y.

**CLIMAX MOLYBDENUM**

Circle 592 on page 19






**Withstands vibration, heat, corrosion — Meets AN-N-5b lock nut specifications**

Here is a ONE-PIECE stainless steel thread insert that will *lock the screw against loosening* as it permanently protects the tapped hole. The secret is in the Mid-Grip coil. Shaped like a polygon, its chords exert a spring pressure on the screw thread and prevent rotation at less-than-rated torque. No loss of torque occurs at elevated temperatures or after repeated disassemblies.

**NO EXTRAS**—The *Heli-Coil** Screw-Lock (Mid-Grip) Insert employs no locking rings, pins, plugs, tabs or wiring. It can be installed from the front or top. Think of the money — and assembly time — you can save!

**NO PROJECTIONS** — Screw-Lock Inserts furnish AN-N-5b lock nut torque *right down inside the parent piece* . . . eliminate costly weight and space . . . improve design.

**NO WEAR, NO CORROSION** — Like regular *Heli-Coil* Inserts, new Screw-Lock Inserts are made from 18-8 stainless steel wire, and normally outlast the unit they protect. They permit smaller, fewer fastenings, and require minimum surrounding material. Screw-Lock Inserts are available in popular NC and NF sizes with choice of two lengths.

Mail coupon for complete data—or better still, see Yellow Pages of your phone directory — "Inserts — Screw Thread" for name of your local Heli-Coil Applications Engineer. Call him now!

Regular *Heli-Coil* Inserts (no locking action) put corrosion-proof, strip-proof stainless steel threads in soft materials . . . permit smaller, fewer fastenings, lighter weight, reduced cost.

**HELI-COIL SCREW-LOCK INSERTS**

*Products of Heli-Coil Corporation*, Danbury, Conn.

*Reg. U. S. Pat. Off.

**HELI-COIL CORPORATION**

130 Shelter Rock Lane, Danbury, Conn.

☐ Send complete design data on *Heli-Coil* Screw-Lock Inserts.

☐ Send design manual on standard *Heli-Coil* Screw Thread Inserts.

☐ Put me on a list to receive "*Heli-Call*," case history periodical.

Name_____ Title_____

Company_____

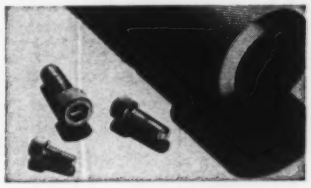
Address_____

City_____ Zone_____ State_____ 3534

IN CANADA: W. R. Watkins Co., Ltd., 41 Kipling Ave. S., Toronto 18, Ont.

Circle 593 on page 19


## New Parts



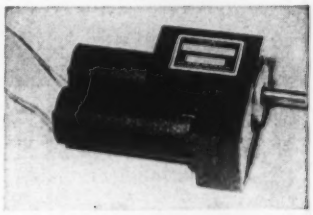
treated and nonmagnetic. Size range is No. 0 to 5/8-in. for cap screws, No. 0 to 1/2-in. for set screws. **Cleveland Cap Screw Co.**, 2921 E. 79th St., Cleveland, O.

Circle 471 on page 19

### Miniature Differential

**utilizes planetary gear reducer**

Planetary gear reducer is used as a mechanical differential device. By mounting the internal gear freely, it may be driven independently of the input shaft, and the resultant speed at the output shaft will be the difference between the speed of the input shaft and the speed



of the internal gear. Illustrated is an application using a conventional motor-driven planetary unit. Holding voltage constant on one unit and varying voltage on the other produces an output speed from 5 rpm in one direction, through 0 rpm to 5 rpm in the other direction for loads up to 1000 oz-in. Wide range of planetary reductions available allows great flexibility in the output speed range with corresponding torque reductions for higher speeds. **Globe Industries Inc.**, 1784 Stanley Ave., Dayton 4, Ohio.

Circle 472 on page 19

### Electric Motor

**is guaranteed for five years**

Fractional horsepower motor, with 5-year guaranteed life, operates with minimum noise, and is designed for low-torque continuous-



Circle 594 on page 19→

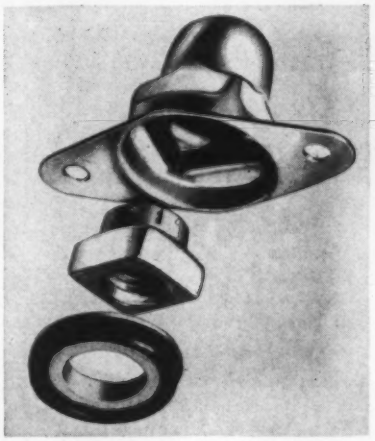
DOW CORNING CORPORATION

# Silicone News

FOR DESIGN ENGINEERS No. 31

## NEW SELF-SEALING FASTENERS MADE PRACTICAL BY SILASTIC

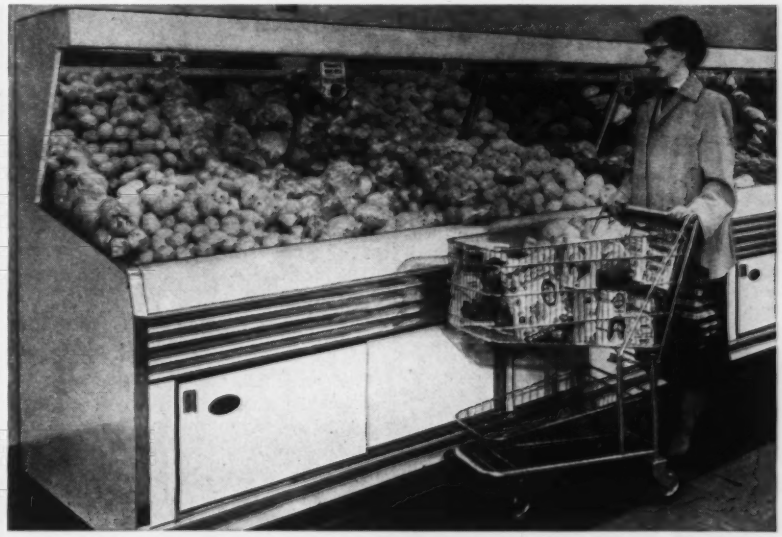
**There seemingly is no end to the design innovations possible with Dow Corning Silicones. A recent example is the self-sealing dome nut for aircraft developed by Nutt-Shel Co., of Pasadena, California. Containing a ring washer made from Silastic*, Dow Corning's silicone rubber, the new fastener maintains a secure seal despite exposure to operating temperatures ranging from —80 to over 500 F.**



Consisting of a retaining shell, self-locking nut and a Silastic-bound ring washer, the assembly is held together in a press fit.

*T.M. REG. U.S. PAT. OFF.

(cont'd pg. 2)



## SILICONE FINISH REPLACES PORCELAIN ON COMMERCIAL REFRIGERATOR CABINETS

**Already well established as excellent protective coatings for high temperature use, silicone based finishes are now successfully challenging conventional coatings long considered unbeatable for "normal" temperature applications.**

Take vitreous enamel or porcelain, for example. A new silicone formulation, Glidden's Nubelon-S, has successfully replaced porcelain on commercial refrigerators produced by the Sherer-Gillett Company of Marshall, Michigan. After using Nubelon-S for two years, Sherer reports that the finish has excellent color retention and that cabinets stay new-looking longer despite abuse from food and beverage stains, abrasive cleaning compounds and shopping cart impacts.

In a test for durability, hammer blows strong enough to dent the metal underneath failed to shatter, crack or chip the silicone based finish. Likewise, the finish on a coated wire shaped into tight coils failed to crack or flake.

Lighter in weight than when coated with porcelain, Sherer-Gillett's silicone finished cabinets are more economical to ship and easier to handle and install. In addition to white, they are available in 5 other sales-stimulating colors.

Sherer-Gillett cabinets are given two coats of Nubelon-S. The flexible silicone coating completely covers all corners and edges, leaving no "black brushing" lines typical of porcelain finishing. Warping is completely eliminated.

*No. 310*

## Allis-Chalmers Selects Silicone Insulation for New Transformers

**Additional evidence of the superior reliability and economy of silicone (Class H) insulation is the fact that motor and transformer manufacturers — the men who know electrical insulation best —don't hesitate to use it in their own plants.**

A case in point concerns several 750 kva silicone insulated dry-type transformers manufactured by the Allis-Chalmers Pittsburgh Works. Three of these units never left the plant. As soon as they were completed, Allis-Chalmers put them on the line supplying power to the plant's six new 360 kva elevator-type electric annealing furnaces.

(cont'd pg. 2)

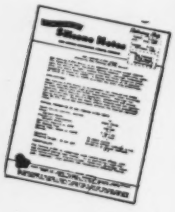
FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

DOW CORNING CORPORATION

# Silicone News

## DOW CORNING PUBLICATIONS ON NEW DEVELOPMENTS AND TECHNICAL DATA . . .



**Documentary film "What's a Silicone?"** available free of charge for showings to technical audiences in every industry. In full color and sound, this dramatic 16 mm film allows you to see Dow Corning Silicones in action improving the performance of products ranging from nursing bottle nipples to diesel locomotives. For more information about this educational film and how to arrange a showing for interested persons in your plant, circle *No. 314*

**Silicone-Glass Laminates** for electrical and mechanical applications are described in new brochure which illustrates parts used in typical industrial applications. Also provides engineering information on silicone-glass laminates and lists fabricators of such laminates. *No. 315*

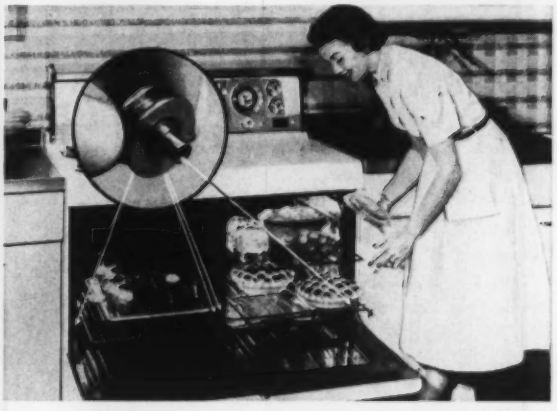
**Dow Corning T-31 glass cloth finish** enables producers of structural laminates to meet most specifications with one type of heat-cleaned glass cloth. Effective with epoxy, phenolic, polyester and silicone resins. Easy to apply with conventional equipment, T-31 requires no buffering before application; no washing, neutralizing or curing after application. *No. 316*

**"New Developments in Silicone Insulation,"** an article reprinted from INSULATION magazine, describes several new insulating components and discusses the relative merits of silicone insulation and "modified silicone insulation." Both systems are essentially the same with the exception of magnet wire insulation. Test results indicate both meet Class H requirements. *No. 317*

**New solvent resistant, low swell Silastic LS-53,** a fluoro-silicone rubber, has excellent resistance to gasoline, aromatic solvents, jet fuels and high aromatic oils. Developed by Dow Corning in cooperation with Wright Air Development Center, this new rubber should have a wide range of applications in aircraft, chemical, petroleum and automobile industries. Presently limited to use in essential Air Force applications, but increased production is expected soon. Preliminary data sheet now available. *No. 318*

## BEARINGS IN KITCHEN RANGE DOORS LUBRICATED WITH SILICONE FLUID

**Stimulated by competition for the billion dollar home appliance market, more and more manufacturers are creating "exclusive" selling features by using Dow Corning Silicones to increase eye-appeal and performance. Take the 40-inch Kelvinator range, for example.**



This all-modern kitchen range features oven doors that function smooth as silk for the life of the range. Easy operation is achieved by mounting the doors on ball bearing bushings. To obtain an extra measure of dependability, the bearings are lubricated with Dow Corning 710 Fluid.

A standard specification since the range was introduced six years ago, the silicone oil provides long term lubricity despite oven temperatures to 500 F, a job no organic lubricant could do. The oil is applied by simply immersing the bearings in 710 Fluid and allowing them to drain.

Exceptional heat stability and oxidation resistance are two reasons why Dow Corning 710 Fluid provides adequate long time lubrication at temperatures from zero to 500 F. Indicative of its stability is a volatility of only 2 per cent after 12 months at 300 F and a gel time of 1500 to 2000 hours at 500 F. *No. 311*

### SELF-SEALING FASTENERS *(cont'd)*

To eliminate possible pinching and subsequent cold flow, the Silastic ring seal is designed to retract into the shell when the nut is attached. When the nut and bolt are in place, the Silastic forms a seal that is unaffected by successive bolt installations.

The Silastic ring maintains a secure seal despite exposure to hot air, ammonia, synthetic oils and gasoline. It has an operating pressure range ± 50 psi and exceeds temperature requirements for aircraft fuel Types 1, 2 and 3 of MIL-R-6855.

Because no sealing compounds are required, installation and maintenance of the fasteners is fast and easy. In fact, the units have proven so successful and economical in use, they are currently specified by eleven leading airframe manufacturers.

Here is another example proving that it pays to consider Silastic for diaphragms, gaskets, seals and other parts that must give reliable service and retain rubber-like properties at any temperature from —130 to over 500 F. *No. 312*

### SILICONE INSULATED TRANSFORMERS *(cont'd)*

The furnaces are designed to heat-treat transformer core steel to over 2000 F in a controlled atmosphere of hydrogen.

Asked why silicone insulation was specified, the engineer in charge of the installation said, **"With Class H, you install them and forget them."** *No. 313*

**Dow Corning Corporation, Dept. 6810, Midland, Michigan**

Please send me: 310 311 312 313 314 315 316 317 318

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

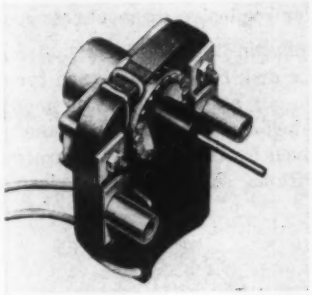
*SILICONE NEWS is published for product design and development engineers by*

DOW CORNING MIDLAND — *first in silicones* — DOW CORNING SILICONES — CORPORATION MICHIGAN

ATLANTA BOSTON CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D.C. (SILVER SPRING, MD.)

CANADA: DOW CORNING SILICONES LTD., TORONTO GREAT BRITAIN: MIDLAND SILICONES LTD., LONDON FRANCE: ST. GOBAIN, PARIS

duty application. Factory lubricated and sealed, the motor requires no lubrication. Motor is available in a variety of corrosion-resistant finishes, also with impregnated coils and stainless-steel shaft. De-



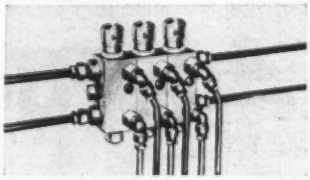
signed for 100 v, 60 cycle, ac operation, unit has low-voltage starting feature. Low-wattage motor, designated Model JS0302, is designed for circulating and cooling fans in refrigerating and air conditioning units. **Alliance Mfg. Co.,** Lake Park Blvd., Alliance, Ohio.

*Circle 473 on page 19*

## Lubrication Counter

**indicates amount of lubricant discharged**

Recording lubrication-cycle counter provides visual indication as guard against bearing failure due to faulty lubrication and provides automatic and permanent record. Counter registers exact number of times lubricant valve is discharged, revealing at a glance whether system is functioning at predetermined intervals selected. Unit, furnished as a kit, screws in-



to valve and may be installed without removing valves from centralized system. Counter extends 1⅝ in. above valve when in operation, and face swivels to any position for easy readings. Totally enclosed unit operates over wide temperature range. Piston action of valve actuates counter mechanism at each lubrication cycle. Unit automatically resets to zero when counter

**Here's A Device Every Machinery Designer Should Know About . . .**

It's the Duff-Norton Worm Gear Jack, successfully used by many machine builders as a component of equipment for precise, positive control of linear motion, applying pressure, resisting impact. Two or more of these jacks can be connected by means of shafting and mitre gear boxes to give a positive drive, so that jacks always raise or lower under equal or unequal loads in perfect unison. Capacities range from 5 to 50 tons with any raise up to 25 inches; worm gear ratios, 8:1 to 96:1; turn of worm for each 1-inch raise, 10 to 180; available in either Acme or square threads. For protection against foreign matter certain models can be furnished with bellows boots.

Thousands of these jacks are in use today for table adjusting—machine adjusting—rolling mill adjusting—raising and lowering conveyors, machine beds, molds and dies, furnace lids, loading platforms, loading racks, gates, hinged mechanisms, arbor presses—adjusting electrodes—overhead crane servicing.

Duff-Norton Worm Gear Jacks are available in 6 standard sizes. For complete specifications and detailed drawings, send for your free copy of a special brochure.

**DUFF-NORTON Company**

DUFF-NORTON COMPANY
Department MD
P.O. Box 1889, Pittsburgh 30, Pa.

Please send immediately a free copy of your new Worm Gear Jack Brochure.

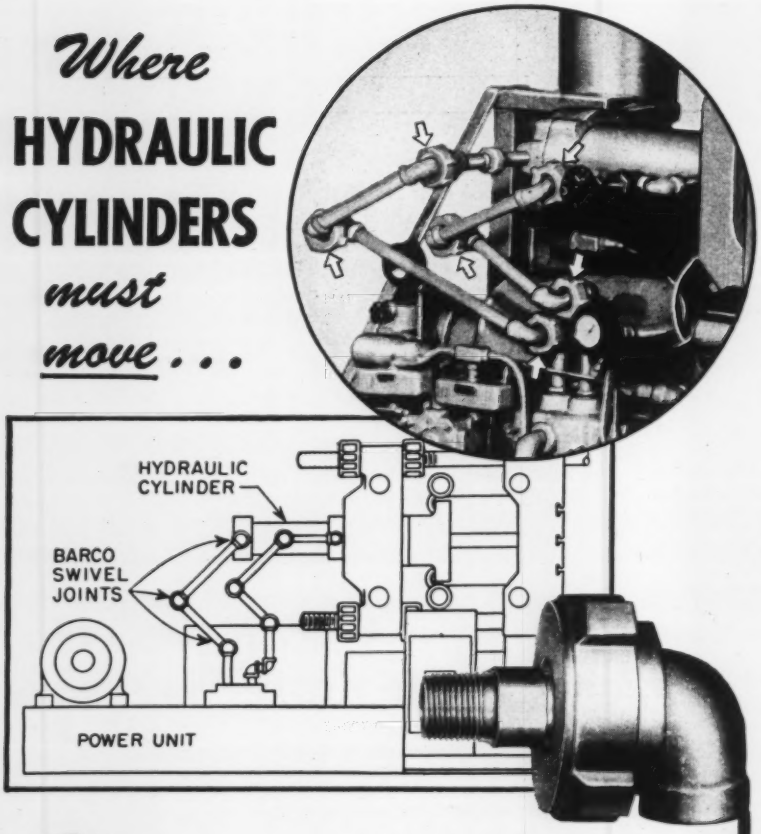
NAME _____ TITLE _____

COMPANY _____ PHONE _____

ADDRESS _____

*Circle 595 on page 19*

*Where*
**HYDRAULIC CYLINDERS**
*must move . . .*




*Use*
**BARCO**
*Self-Aligning*
**SWIVEL JOINTS**

THE Barco "Self-Aligning" Swivel Joint is one of the most useful, most versatile fittings ever developed for making flexible piping connections to moving or movable parts on injection molding presses, die casting machines, and other hydraulically operated equipment.

**ENGINEERED INSTALLATIONS**—Easy to position piping accurately. Put flexibility where you want it—without the nuisance of sagging, flopping, non-rigid lines. No restricted internal diameters.

**BETTER CONTROL**—No swelling or expansion in lines under pressure. Positive control action—no "mushiness."

**PRESSURE SAFE**—Barco Joints will not break or blow out suddenly. High temperature and fire resistance. Installations stay leakproof. No lubrication required.

**EASY TO INSTALL**—Barco's *self-aligning* feature simplifies and speeds up installation, saves time in pipe fitting, prevents binding, and minimizes wear.

Barco builds a complete line of swivel joints for every purpose. Ratings as high as 600°F., 3,000 psi (hydraulic). Sizes ⅜" to 2"; angle or straight. For complete information and recommendations, see our nearest representative or write BARCO MANUFACTURING CO., 506L Hough St., Barrington, Illinois.

**ASK FOR BULLETIN 265A**

**BARCO**

*THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING, AND REVOLVING JOINTS*

Circle 596 on page 19


## New Parts

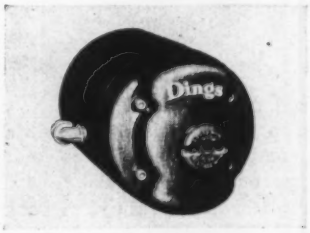
reaches 99. **Stewart-Warner Corp.**, Alemite Div., 1826 Diversey Pkwy., Chicago 14, Ill.

Circle 474 on page 19

### Magnetic Brake

**for explosive atmospheres**

Explosion-proof direct-acting magnetic disk brake is designed for use with all standard electric motors. Brakes have been tested and approved by UL for use in hazardous locations. Two basic styles are



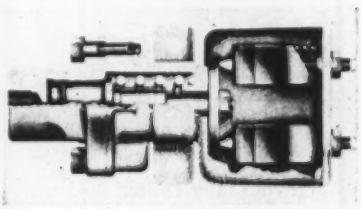

available: Series 709, which incorporates a thermal release to automatically release brake if housing temperature approaches dangerous limit; and Series 707, which is built to withstand an internal explosion. Brakes are available with motor-mounting or foot-mounting. **Dings Brakes Inc.**, 4740 W. Electric Ave., Milwaukee 46, Wis.

Circle 475 on page 19

### Pressure Switch

**controls two independent electrical circuits**

Pressure switch is capable of sensing two different pressures in one system and actuates two independent electrical circuits. Switch may



be used to maintain a pressure where it is imperative that system pressure does not exceed or fall below predetermined values. Unit accurately senses any system pressure over an adjustable range of 15 to 3000 psi for proof pressures from 3000 to 7000 psi, depending upon switch setting. Two snap-ac-

EATON

# DYNAMATIC®

# SINGLE PACKAGE FRACTIONAL HP AJUSTO-SPEDE® DRIVES

## Provide Stepless Adjustable Speed from an AC Power Source

**Sizes and Types for Hundreds of Industrial Applications**

Dynamatic Ajusto-Spede® Drives, part of a family of diversified eddy-current equipment, provide an economical solution to many adjustable speed drive problems.

The Fractional Horsepower Ajusto-Spede, a single package design, combines an AC constant speed induction motor, eddy-current coupling, and electronic control. Standard modifications provide for the addition of electrically operated fail safe friction brakes, or speed reducers with numerous gear reduction ratios.

Fractional Horsepower Ajusto-Spede Drive power is taken directly from 115/220 volt, single phase or 220/440 volt, 3 phase lines. Sizes are ¼, ⅓, ½ and ¾ horsepower at 1600 RPM; ½, ¾ and 1 horsepower at 3200 RPM.

Friction brakes for quick stopping or fast cycling operation are furnished in two capacities—1½ and 3 pounds feet of torque.

Gear reductions with 10 ratios between 5-to-1 and 100-to-1 are supplied with 1600 RPM Ajusto-Spedes.

## *Ajusto-Spede® Advantages*

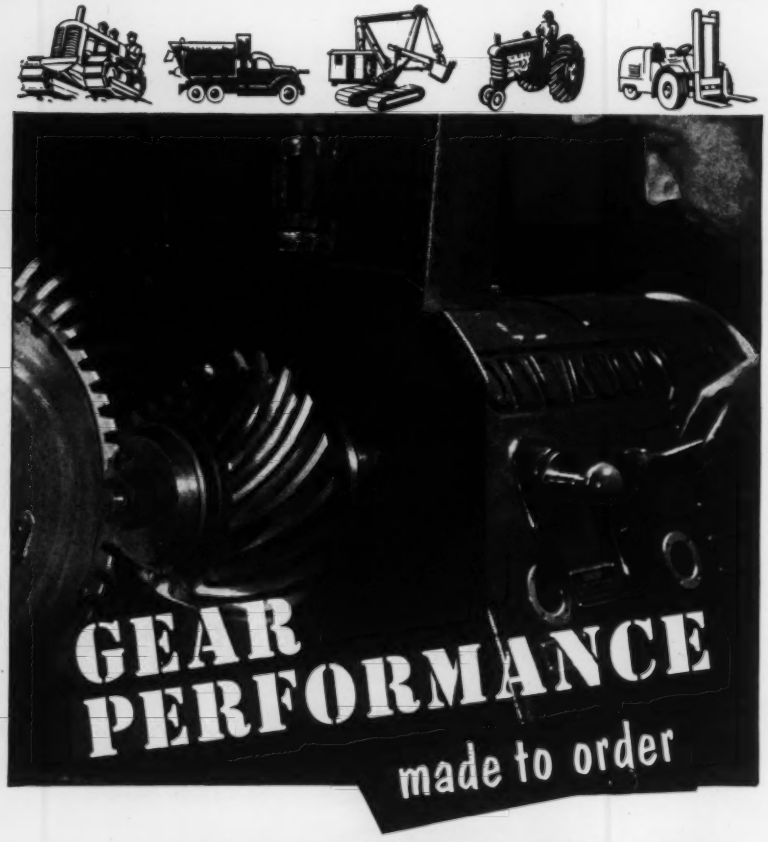
- ★ **Constant torque speed range: 25 to 1 with either 1600 RPM or 3200 RPM Ajusto-Spedes.**
- ★ **Control accuracy: 2 per cent of top speed at any point within the speed range.**
- ★ **Minimum wiring to power line.**
- ★ **Remote "one knob" control operation up to 100 feet.**
- ★ **Rugged plug-in type integral one-tube electronic control.**
- ★ **Permanently sealed grease-packed bearings.**

*For more detailed information, write for your free copy of the Dynamatic Fractional Horsepower Ajusto-Spede Bulletin, FAS-5.*

**EATON** — *DYNAMATIC DIVISION*
**MANUFACTURING COMPANY**
**3307 FOURTEENTH AVENUE • KENOSHA, WISCONSIN**



*Circle 597 on page 19*




# by FAIRFIELD

GEAR PERFORMANCE to match the ever-increasing power and speed of modern machines is Fairfield's specialty. This is possible because Fairfield has constantly held a position of leadership in utilizing the most advanced methods, machines, and techniques for producing better gears. By keeping apace with modern engineering trends, Fairfield renders an invaluable service to many of the nation's leading machinery builders: *"Gear Performance Made to Order!"*

Users also get the advantage of Fairfield's *mass production economy* extending over a complete range of gears: Spiral Bevel, Straight Bevel, Hypoid, Zerol, Spur, Herringbone, Worms and Worm Gears, Splined Shafts, and Differentials. Available, too, are expert recommendations for any gear problem users may have. *Ask for interesting, illustrated bulletin describing Fairfield facilities.*

**FAIRFIELD**
MANUFACTURING CO.

2307 S. Concord Rd. Lafayette, Indiana

Circle 598 on page 19


## New Parts

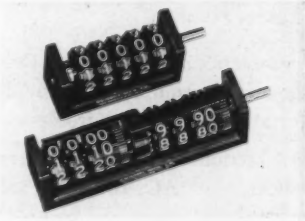
tion switches, rated for ac or dc, are electrically independent of each other. Piston-type sensing element performs for millions of cycles under fast, continuous operation and is not sensitive to jarring or vibration. Pressure settings are made by two external screws which may be locked in place. Two calibrated dials on model C9622 enable either switch to be set visually before or after installation on line. **Barksdale Valves,** Pressure Switch Div., 5125 Alcoa Ave., Los Angeles 58, Calif.

Circle 476 on page 19

### Instrument Counters

**96 different models have continuity of configuration**

Instrument counters, Series Y, in 96 different models with identical case, wheel, and component configuration, permit users to have continuity throughout all types of equipment where indicators are used. Model variations include single-bank read-out from 2 to 7 digits and double-bank read-out from 2 to 5 digits in each bank. Counters have intermittent duty



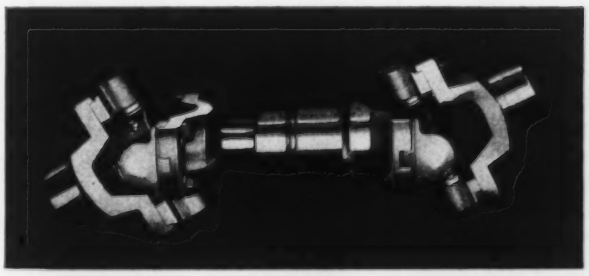
speeds to 2500 rpm. Frames are zinc-chromate coated aluminum, finished in black enamel. Shafts are stainless steel, bearings are impregnated oilite, and wheels and pinions are fungus-proofed black nylon. Figures are $\frac{3}{16}$-in. high by 9/64-in. wide, white on black or fluorescent color on black. Counter cases range from $1\frac{1}{8}$ in. to 4 in. long, by $\frac{3}{4}$-in. deep and $1\frac{1}{16}$ in. high. Weights are $\frac{3}{4}$-oz to $3\frac{1}{2}$ oz. Applications are navigational instruments, missile tracking instruments, radar controls, computers, and similar instruments and electronic devices. **Durant Mfg. Co.,** 1933 North Buffum St., Milwaukee 1, Wisc.

Circle 477 on page 19

SPECIFY KEY-DRIVE JOINTS FOR **SAFE** LESS WEIGHT TORQUE TRANSMISSION

MECHANICS Roller Bearing UNIVERSAL JOINTS increase the Safety factor in power transmission lines, because heavy, machined KEYS and corresponding keyways, not bolts nor screws, transmit the torque. The only function of the cap screws is to hold the bearing assemblies in place.

This KEY method of driving has the highest safety factor, transmits the most torque with the least weight, and avoids costly breakdowns resulting from driving through bolts or screws that work loose.



Let our engineers show you how this and several other MECHANICS Roller Bearing UNIVERSAL JOINT advantages will benefit your new and improved products.

**MECHANICS UNIVERSAL JOINT DIVISION**
**Borg-Warner • 2032 Harrison Ave., Rockford, Ill.**
Export Sales: Borg-Warner International
36 So. Wabash, Chicago 3, Illinois

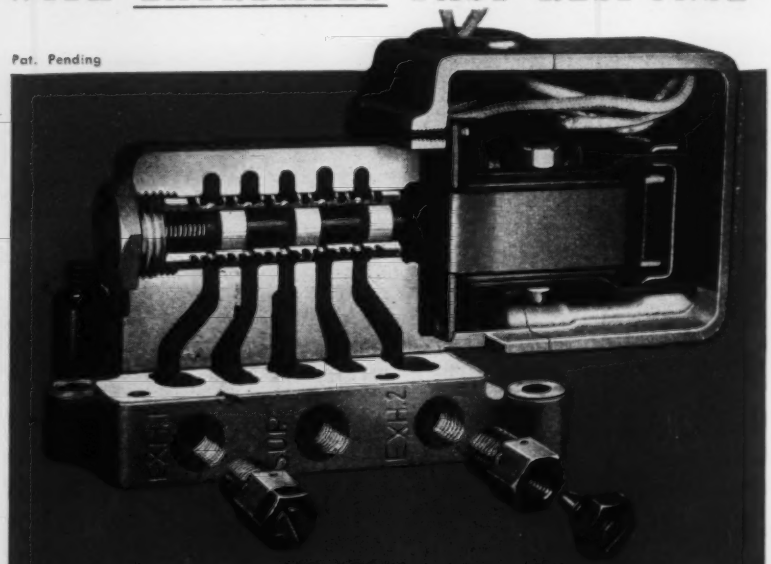
# MECHANICS
## *Roller Bearing* BW
# UNIVERSAL JOINTS

**For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment**

# now . . . AIR VALVES

## WITH EXTREMELY FAST RESPONSE

Pat. Pending



. . . Almost TWICE As Fast As Ordinary Valves!

The new SA Series single solenoid actuated valves are available in both single and dual pressure models with extremely fast response time. You get total response in 12 *milliseconds*—from energizing to wide open on 60 cycle current. That's almost *twice as fast* as any pilot operated solenoid control valve available today!

All SA Series valves are high performance, full pipe area valves . . . furnished for service on vacuum and air at pressures from atmospheric to 250 psi . . . and at speeds from the most intermittent job in your plant to welding guns. Optional metering valves give simple, sensitive control of piston speed by metering the exhaust air. Exhaust noise is muffled.

The design simplicity of the SA Series valves provides extremely long life and requires a real minimum of maintenance. Only one moving part provides the valving action . . . a corrosion-resistant steel spool and sleeve.

Complete information on the SA Series valves . . . the greatest advance in air controls . . . can be obtained by writing today for your copy of Catalog 8000.

# NUMATICS, Inc.

MILFORD, MICHIGAN • DEPT. MD

Circle 600 on page 19


## ENGINEERING DEPARTMENT

# EQUIPMENT

### Vibrometer

**has miniaturized pick-up probe**

Vibrometer measures acceleration, velocity, and displacement of mechanical vibrations from 3 to 20,000 cps. Displacement range is 0.001 in. to 3.0 in. in eight 10-db steps, velocity range is 0.3 in. per sec to 1000 in. per sec in eight 10-db steps, and acceleration range is

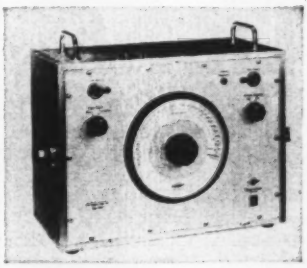
10 in. per sec$^2$ to 300,000 in. per sec$^2$ in eight 10-db steps. Polarity switch determines positive and negative peaks. Miniaturized probe makes possible accurate measurements on small, low-energy vibrating systems. When used with oscilloscope, quantitative analysis of impact shock and impulsive motions are obtained. **Televiso Corp.**, 1415 Golf Rd., Des Plaines, Ill.

*Circle 478 on page 19*

### Filter Set

**for audio signal or vibration analysis**

One-third octave filter set is for sound and vibration analysis, measurement of sound transmission and reverberation time, any audio-signal analysis, or telemetry data reduction. Filter set consists of 27 flat-topped filters of ⅓ octave band-pass width with seven additional filters available to cover frequency spectrum of 14 to 36,000 cps. Instrument contains weighting networks for overall loudness measurements and a



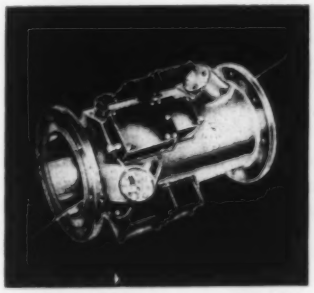
linear band pass. Response is ±2 db of linear level. Filters are manually selected with 50-position switch or automatically scanned by motor. Stepping switch is non-shorting type and allows output of all filters to be simultaneously transmitted to readout equipment. **Brush Electronics Co.**, 3405 Perkins Ave., Cleveland 14, O.

*Circle 479 on page 19*

### Ultrasonic Flowmeter

**offers no obstruction to liquid flow**

Direct-reading ultrasonic flowmeter gives simultaneous readout of mass flow rate, mass totalization, volumetric flow rate, volumetric totalization, and fluid density. Device utilizes ultrasonic



energy to determine volume or mass of fluid passing through smooth-bore sensor which offers no obstruction to flow and no subsequent additional pressure drop. Readouts can be made on indicator or recorder remote from sensor. Unit for a 4 in. line is 10 in. long and weighs 10 lb. Application is for measuring fluid flow accurately at high transfer rates and wide temperature ranges, as in fuel gaging for aircraft and missiles. **W. L. Maxson Corp.**, Maxson Instruments Div., 47-37 Austell Place, Long Island City 1, N. Y.

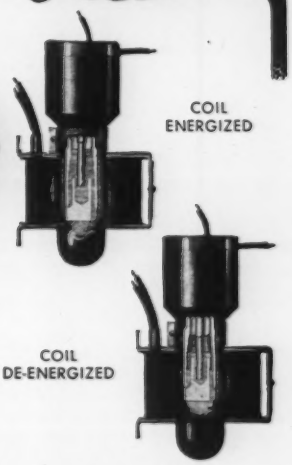
*Circle 480 on page 19*


*The*
**TIMER RELAY that eliminates controlled timing problems**

★ No false contacts
★ Non sticking
★ Practically "fail safe"
★ Low cost timer

**Durakool**
STEEL MERCURY TIMERS

This steel clad, factory set, tamper proof Durakool timer-relay is practically non-breakable. Operating life multiplied 5 to 6 times by new plunger construction features. Any combination of operate-release time delays from 0.15 sec. to 20 sec. — either normally open or normally closed action.

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700 WESTON RD., TORONTO 9, CANADA

Send for Bulletin 800

*Circle 601 on page 19*

Your Own COMPARISON TEST **PROVES**

**NU-CUP®** SET SCREWS **have greater holding power**

the shaft tells the story!

Without cost or obligation, send for "Nutcracker" Testing Tongs to compare Nu-Cups, yourself, with set screws you now use. See with your own eyes conclusive proof of Nu-Cup's greater holding power. See how Nu-Cups end slippage, screw heads cracking, and other set screw troubles.

Full Circle impression of Nu-Cup . . . greater holding power.
Half-Circle Skid Mark of Conventional Screws . . . permits slippage.
And This Is The Reason:
Nu-Cup 42° Sharper-Angle Point Permits Higher Setting Torques
Higher Torques Impossible with Conventional Wide-Angle Point

Pat. Pend.

**Nu-Cup now available with Hex Socket Head . . . as well as slotted or slabbed head.**

No need to write a letter. Simply fill out and mail the coupon at the right, to get your "Nut-Cracker" Nu-Cup Tester. Send for it now.

**Set Screw & Mfg. Co.**
**28 Main St., Bartlett, Ill. (Chicago suburb)**
1137PDMRT *We specialize in Solving Puzzling Set Screw Problems*
**Use This Convenient Coupon**

**SET SCREW & MFG. CO., 28 Main Street, Bartlett, Illinois**

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ADDRESS.....
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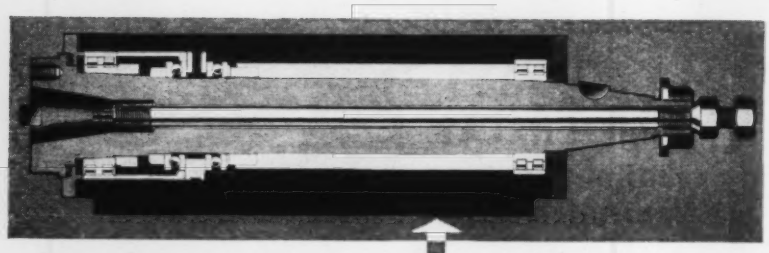
*Circle 602 on page 19*



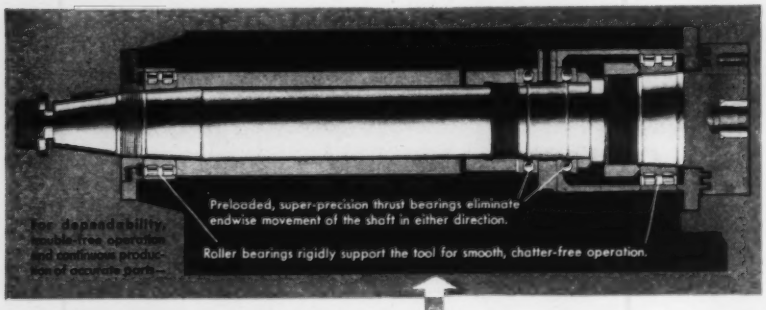
**PRECISION MILLING** calls for this

**POPE** Heavy Duty MILLING SPINDLE

See for yourself! Here is one sturdy package with a massive shaft, and double row cylindrical roller bearings and ball thrust bearings that support your cutting tools rigidly to do their best work.

POPE P-12000 Series Belt Driven Precision Milling Spindles are operable in any position. They come in sizes from 1 to 50 HP with standard milling machine tapers in the nose from #10 to #60. Bulletin S-8 gives complete dimensions. Let us mail you a copy.

POPE Heavy Duty Milling Spindles are also available in P-2500 Series, MOTORIZED, from 1 to 100 HP, totally enclosed, fan cooled; and in high cycle, water cooled units.


For dependability, trouble-free operation and continuous production of accurate parts—
Preloaded, super-precision thrust bearings eliminate endwise movement of the shaft in either direction.
Roller bearings rigidly support the tool for smooth, chatter-free operation.

**PRECISION BORING** calls for this

**POPE** Heavy Duty BORING SPINDLE

Look it over! Here is a Boring Spindle capable of boring holes round within *millionths of an inch.* It produces fine surface finishes in the lower micro inch range.

POPE Super-Precision Heavy Duty Boring Spindles are available in both belt driven and motorized units to meet a wide range of speeds and horsepower. Send us your specifications for quotations.

**Pope designs, engineers and builds SPECIAL SPINDLES**

No. 112

*Specify* **POPE** PRECISION SPINDLES — POPE MACHINERY CORPORATION

*Circle 603 on page 19*

# THE ENGINEER'S Library

## *Recent Books*

**Mechanical Vibrations, 4th Edition.** *By J. P. Den Hartog, professor of mechanical engineering, Massachusetts Institute of Technology;* 433 *pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 West 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, $9.00 *postpaid.*

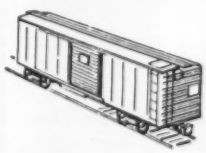
This book is intended both as a textbook for senior and graduate students and as a reference work for practicing engineers. First published in 1934, the present edition is up to date and new material has been added. The text includes many vibration problems encountered by the practicing engineer. The book opens with a study of the kinematics of vibrations and vibration in systems with single, double, and multiple degrees of freedom. Vibrations in multicylinder engines and rotating machinery are presented, and the final chapters are devoted to self-excited vibrations and systems with variable characteristics.

♦

**Random Processes in Automatic Control.** *By J. Halcombe Laning Jr., deputy associate director, and Richard H. Battin, assistant director, Instrumentation Laboratory, Massachusetts Institute of Technology;* 426 *pages, 6 by 9 in., clothbound; published by McGraw-Hill Book Co. Inc., 330 W. 42nd St., New York 36, N. Y.; available from* MACHINE DESIGN, $10.00 *postpaid.*

This book provides a basic background in the theory of random signals and noise, together with practical techniques to be used in the analysis and synthesis of linear control systems which are subjected to random inputs. Original material and recent advances in the field are integrated with the text. The book treats the basic concepts of probability and random time functions and then uses these

# Box-car-size stresses are no problem for Tinnerman SPEED GRIPS®!



A new Lading Strap Anchor developed by the Pullman-Standard Car Mfg. Co., Chicago, is attached to guide plates by Tinnerman SPEED GRIP Nut Retainers. This anchor now makes it possible for shippers to fasten heavy loads in box cars without nailing or shoring. SPEED GRIPS were selected to make these heavy-duty attachments because no other fastener offers so many advantages for blind-location assembly.

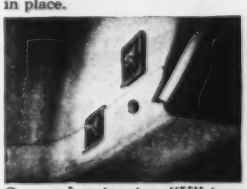
SPEED GRIPS are the most efficient method of attaching square nuts to panels. Welding, clinching, staking are eliminated. No special skills or tools are required. SPEED GRIPS snap quickly, easily into panel holes, hold themselves in bolt-receiving position after the guide plate is attached to the box car side. They're rustproof, can be applied after painting, eliminating costly masking or retapping of paint-clogged threads. What's more, the nut "floats" in its spring steel cage to help correct normal misalignment in mounting holes!

Find out about the complete line of SPEED GRIPS and more than 8,000 other SPEED NUT brand fasteners. See your Tinnerman representative soon or write to us.

TINNERMAN PRODUCTS, INC., BOX 6688, DEPT. 12, CLEVELAND 1, OHIO

*Canada:* Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). *Germany:* Hans Sickinger GmbH "MECANO," Lemgo-i-Lippe.

Snap-on SPEED CLIP® cuts costs by replacing 4-piece screw clamp to hold fractional-h.p. motors in place.

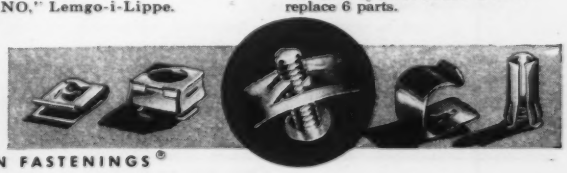


On garden tractor, "U" type SPEED NUTS make heavy-duty attachment of hood to yoke, cut assembly costs, parts handling.

Appliance thermostat control is assembled faster, easier, at less cost as 2 special SPEED CLIPS replace 6 parts.

TINNERMAN Speed Nuts

FASTEST THING IN FASTENINGS®



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THE BIG LUG OF INDUSTRY

**For Superior Quality**
**√ Check these features**

- ☐ Pure copper, 100% conductivity
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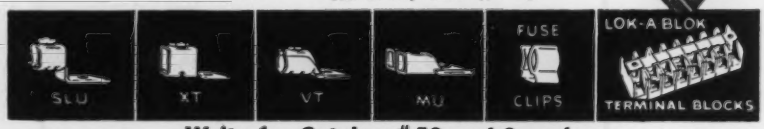
- ☐ U/L-CSA Approved
- ☐ Compact—rugged
- ☐ Advanced designing
- ☐ Sound engineering
- ☐ Speedy installation
- ☐ Cool operation—takes overload
- ☐ No special tools needed
- ☐ All screws wax-treated for better clamping

ALL THESE FEATURES AT LOW COST

*Your √ Test Will Prove ILSCO Superiority Over Cast Or Any Other Type Lugs*

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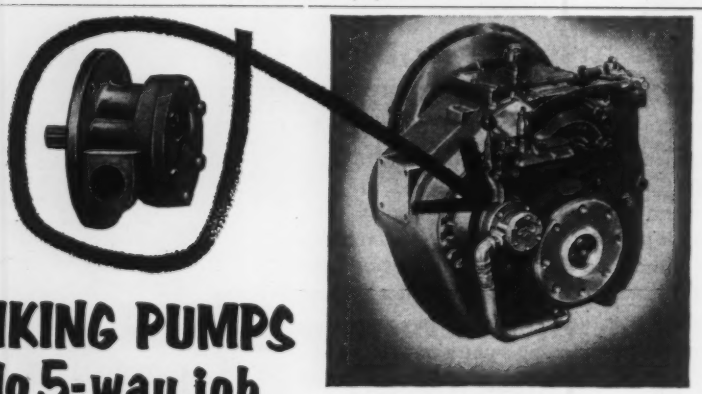
*Circle 605 on page 19*



# VIKING PUMPS do 5-way job

## on Twin Disc Clutch's New Marine Gear

Twin Disc Clutch Company, Racine, Wisconsin, designed their new MG-11 Marine gear for the new high speed, high horse power marine engines. They spent three years in research, designing, planning and testing. Viking Pumps were selected to perform five functions—1. Actuate the clutches, 2. Carry heat away from clutches, 3. Give smooth clutch engagements, 4. Reduce clutch plate wear, and 5. Force-feed lubricate meshing gears.

Besides Marine use, Vikings are pumping dependably in petroleum, chemical, foods, and many other fields. If you have a pumping problem, call on Viking. To start, write for bulletin 56Sh.

**VIKING PUMP COMPANY**

Cedar Falls, Iowa, U.S.A. In Canada, it's "*ROTO-KING*" pumps

See our catalog in Sweets

*Circle 606 on page 19*


## The Engineer's Library

fundamentals to develop analysis and design techniques for linear control systems containing both constant and time-varying components. Emphasis is given to the nonstationary problem and the use of modern automatic computing equipment to provide solutions to such problems.

•

**Reactor Shielding Design Manual.** *Edited by Theodore Rockwell III, technical director, Naval Reactors Branch, Division of Reactor Development, United States Atomic Energy Commission; 465 pages, 8 x 10½ in., clothbound; published by D. Van Nostrand Co. Inc., 120 Alexander St., Princeton, N. J.; available from* MACHINE DESIGN, *$6.00 postpaid.*

Based on work of the Atomic Energy Commission in the design, construction and testing of shielding for reactor plants, this volume presents shield design methods and general design formulas. A section on materials deals with basic components of shields. Included are tabulations on flux-to-dose conversion, build-up factors, gamma rays resulting from neutron capture, and various formulas for different shield geometries.

## New Standards

**ASTM Standards on Copper and Copper Alloys.** *615 pages, 6 by 9 in., paperbound; published by and available from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.; $5.75 per copy.*

This volume is a collection of all of the ASTM standards pertaining to copper and copper alloys. Standards cover copper, copper-alloy, and copper-covered-steel electrical conductors; copper and copper-alloy plate, sheet, strip, rolled bar, rod, shapes, forgings, wire, pipe and tube; filler metal methods of testing; and copper-alloy castings.

## Association Publications

**ASTM Special Technical Publications.** *Each booklet is 6 by 9 in., paperbound; published by and avail-*

*able from American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.*

The following booklets are available:

No. 171 **Basic Effects of Environment on the Strength, Scaling, and Embrittlement of Metals at High Temperatures**—114 pages; $2.75 per copy.

No. 174 **Symposium on Metallic Materials for Service at Temperatures Above 1600 F**—193 pages; $3.00 per copy.

No. 175 **Symposium on Atmospheric Corrosion of Non-Ferrous Metals**—158 pages; $2.75 per copy.

No. 183 **The Mechanical Properties of Wrought Phosphor Bronze Alloys**—114 pages; $3.00 per copy.

## Manufacturers' Publications

**Alcoa Aluminum Handbook.** *169 pages, 5½ by 8 in., paperbound; prepared by and available on company letterhead request from Aluminum Company of America, Pittsburgh 19, Pa.*

Aluminum alloys and their properties, sizes, tolerances, and fabricating data are covered in this reference book. The introductory section explains the code numbering system used to designate alloys and their modifications. Subsequent sections deal with wrought alloys, sheet and plate, wire, rod, bars, extrusions, tube and pipe, electrical conductors, structural shapes, forgings, and casting alloys.

## Government Publications

**NACA Technical Series.** *Each Publication is 8 by 10½ in., paperbound, side stapled; copies available from National Advisory Committee for Aeronautics, 1924 F. St., N. W., Washington 25, D. C.*

The following Technical Memorandums are available:

1395. **The Fatigue Strength of Riveted Joints and Lugs**—54 pages.

1419. **Effects of Intermittent Versus Continuous Heating upon the Tensile Properties of 2024-T4, 6061-T6 and 7075-T6 Alloys**—7 pages.

The following Technical Notes are available:

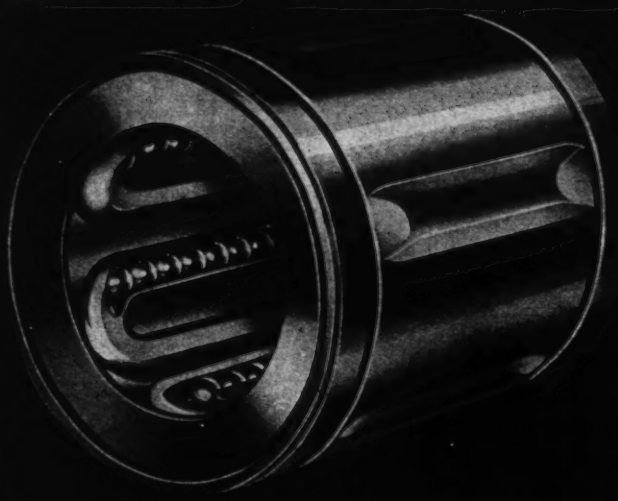
3731. **Tensile Properties of Inconel and RS-120 Titanium-Alloy Sheet Under Rapid-Heating and Constant-Temperature Conditions**—29 pages.

3735. **Bending Tests of Ring-Stiffened Circular Cylinders**—14 pages.

3736. **Poisson's Ratios and Volume Changes for Plastically Orthotropic Material**—28 pages.

3742. **Tensile Properties of HK31XA-H24 Magnesium-Alloy Sheet Under Rapid-Heating Conditions and Constant Elevated Temperatures**—20 pages.


BALL BUSHING



The BALL BEARING for your

LINEAR MOTIONS

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A or Low-Cost Series B BALL BUSHINGS.

Alert designers can now make tremendous improvements in their products by using BALL BUSHINGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

Improve your product. Up-date your design and performance with BALL BUSHINGS!

**Now manufactured for ¼", ½", ¾", 1", 1½", 2", 2½", and 3" shaft diameters.**

**LOW FRICTION • LOW MAINTENANCE**
**ELIMINATES BINDING AND CHATTER**
**SOLVES SLIDING LUBRICATION PROBLEMS**
**LONG LIFE • LASTING ALIGNMENT**

**Progressive Manufacturers Use Ball Bushings —A Major Improvement at a Minor Cost**

**THOMSON INDUSTRIES, Inc.**

**Dept. E, MANHASSET, NEW YORK**

*Write for descriptive literature and the name of our representative in your city.*

Also manufacturers of NYLINED Bearings — DuPont NYLON within a metal sleeve—for rotation and reciprocation.

Circle 607 on page 19

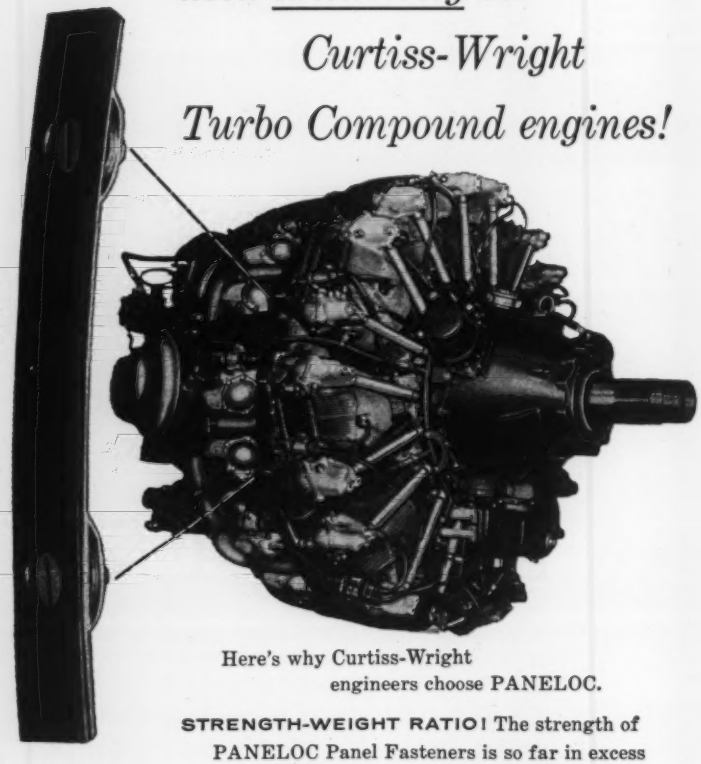
# PANELOC

*panel fasteners*

*used exclusively on*

*Curtiss-Wright*

*Turbo Compound engines!*



Here's why Curtiss-Wright engineers choose PANELOC.

**STRENGTH-WEIGHT RATIO!** The strength of PANELOC Panel Fasteners is so far in excess of requirements of governing specifications that fewer fasteners are required to do a particular job. This saves the weight of extra fasteners.

**LONG LIFE!** PANELOC Panel Fasteners are still operative when baffles and ducts wear out. Maintenance is thereby reduced to a minimum. The need for replacements is virtually eliminated.

**ECONOMY!** The cost of extra fasteners is eliminated and the cost of installation and maintenance reduced when PANELOC Panel Fasteners are used.

Write for catalogues and price lists on Styles 1, 2 and 3 Panel Fasteners.

*A product of* SCOVILL

*Scovill Manufacturing Company, Aircraft Fastener Div.*
*50 Mill Street, Waterbury 20, Connecticut*

Circle 608 on page 19


# New Machines

## Materials Handling

**Fork Truck:** Model F-45T3 electrically powered fork truck with 3000-lb capacity has roller-mounted inner uprights and elevator carriage, operator's protective cowl, automotive-type controls, low hydraulic pressure, contactor controls, center sill frame and worm drive. Angle of wheel turn is sharp to provide good maneuverability in congested areas. Two standard models are 68 and 83 in. high. Travel speed at full load is 6.3 mph; lift speed, 30 fpm. *Elwell-Parker Electric Co., Cleveland.*

**Punch Press Feeder:** Hydraulically operated FC-3232 heavy-duty punch press feed handles stock 32 in. wide, 0.250-in. thick, and has a maximum stroke length of 32 in. The unit operates under a pressure of 500 psi. A force of 2400 lb pulls the stock through the feed while the gripping pressure on the stock is approximately 12,000 lb. Pressures can be increased or decreased by changing the pump pressure within the limitations imposed by the horsepower of the motor. Timing of the feed with the press is accomplished by a limit switch mounted on the press. Hydraulically operated stock retainers are mounted at the press end of the feed to hold the stock while the grippers move back for the next stroke. Provision is made in the electrical control panel for cutting out the hydraulic retainers when desired. Mechanical stock retainers are also incorporated in the feed. *Special Engineering Service Inc., Detroit.*

## Metalworking

**Milling Machine:** Pedersen Model VPV-2 milling machine design incorporates vertical spindle supported by a heavy, tapered-roller bearing and friction clutch to disengage feed when excessive overloads are encountered. Spindle

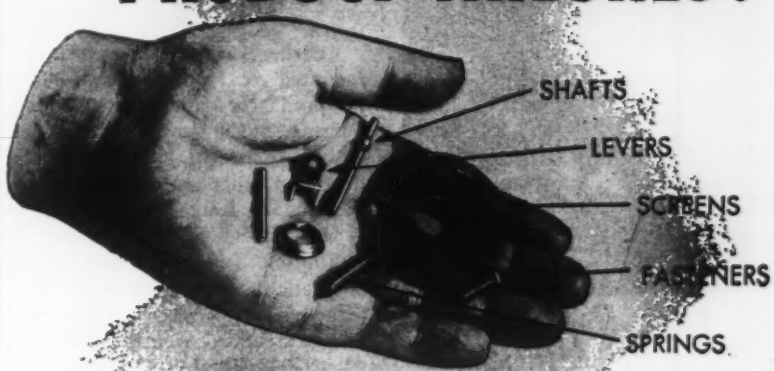
sleeve can be moved 3 in. in axial direction and locked securely in any position desired. Spindle head can be swiveled to each side, and is provided with a graduated scale and simple fine adjustment device. Engagement of the rapid traverse lever reverses the direction of feed. *Aaron Machinery Co., Inc., New York.*

**Lapping Machine:** Model 18 lapping machine has an 18-in. diam lapping plate and produces microinch finishes on small and medium-sized parts such as gages, sliding and rotating parts, air and liquid tight seals and valves. It attains optical flatness to 2 rms or finer. No collets, chucks or holders are used. Lapping plate is firmly supported by six precision, permanently sealed ball bearings, mounted on hardened and ground eccentric bushings. Gear box is aluminum with bronze bushings for rotating parts. Motor and gear box are readily accessible for maintenance. *Spitfire Tool Co., Chicago.*

**Draw Presses:** Welded steel, under-drive mechanical draw presses are available in sizes from 500 to 1000-ton capacity with beds from 72 x 84 to 100 x 200 in. Various cycle sequences can be obtained. Driving mechanism is located in the press bed for easy inspection and maintenance out of the way of production. Swivel arrangement of counterbalance cylinders permits them to align properly when gibs are adjusted. Both automatic and gravity-flow lubrication is provided to all bearings. The presses use an eddy current clutch, and are equipped with safety die blocks and die lights. *Baldwin-Lima-Hamilton Corp., Hamilton, O.*

**Hydraulic Press Brake:** Up to seven different angles in succession without resetting controls can be formed by a new press brake. All bends on a piece of metal are formed in one handling by presetting controls only once. Range is from 12-in. deep bends formed in a single stroke to bends of less than ⅛-in. with press cycling at 50 strokes per minute or more. The unit is accurate to within thousandths of an inch. Work can be done at any point along the en-


ARE *small* PARTS CAUSING YOUR PRODUCT FAILURES?




It Will Pay You To Use ALLOYS

How many times can you trace your product failure to the corrosion, wear or breakage of some small part? A screw . . . a shaft . . . small spring . . . a gear or other seemingly insignificant part? In most cases the failure can be blamed on the material from which the part was made. The use of Nickel Alloys or Stainless Steel Wire, Rod or Strip for these parts could have saved many dollars in service and replacement costs because of their superior engineering properties.

How much more will alloy materials cost? Actually, on small parts, fabrication, finishing and other manufacturing costs will more than likely far overshadow material cost. You will find that the extra cost of using alloys will be insignificant compared with the benefits in longer service life, lower maintenance costs and fewer customer complaints.

For informative technical data on our alloys . . . and for some good ideas . . .

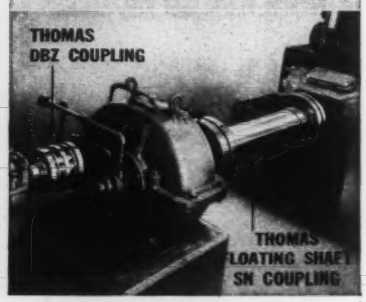
*SEND TODAY FOR OUR NICKEL ALLOY AND STAINLESS STEEL DESIGN HANDBOOKS.*

ALLOY METAL WIRE DIVISION

HKP H. K. PORTER COMPANY, INC.
Prospect Park, Pennsylvania

Circle 609 on page 19

# Freedom From Coupling Maintenance




## Install Thomas Flexible Couplings

*First* cost is *only* cost when you buy Thomas Flexible Couplings . . . because Thomas Flexible Couplings are correctly engineered . . . have no wearing parts . . . need no lubrication . . . eliminate future maintenance costs. Even more, Thomas all-metal couplings are open for inspection while running—ending inspection shut-downs!

For all practical purposes, properly installed and operated within rated conditions, Thomas Flexible Couplings will last forever.

**NO LUBRICATION . . .**
**NO MAINTENANCE . . .**
There Are No Wearing Parts

Under load and misalignment, only Thomas Flexible Couplings offer all these advantages:

1. Freedom from backlash—torsional rigidity
2. Free end float
3. Smooth, continuous drive with constant rotational velocity
4. Visual inspection while operating
5. Original balance for life

*Write for Engineering Catalog 51A*

**THOMAS**
**FLEXIBLE COUPLING CO.**
WARREN, PA.

Circle 610 on page 19


## New Machines

tire length of bed. Piece can be passed progressively from die to die for blanking, deep drawing, embossing, punching and forming. The press brake is used also for straightening, rubber pad forming, pipe making, stretching, extruding, hot forming, and shearing heavy plates. *Pacific Industrial Mfg. Co., Oakland, Calif.*

### Processing

**Finisher and Buffer:** Bench mounted rotary finisher and buffer is used for abrasive finishing, burring, buffing, sanding and polishing of metal, wood, plastics, fiber and other materials. It uses a standard hinged roll, and any type of emery cloth, sandpaper or buffing cloth is easily inserted. It is available with or without disk attachment. Work rest for the disk attachment is adjustable from 45 to 90 deg. Specifications include 1/3-hp, 110-v, 60-cycle, 1-phase motor and 1750 rpm direct drive. *Mathewson Machine Works Inc., Quincy, Mass.*

**Injection Molders:** Semiautomatic plastics injection molding machines, designated models 356 and 356A, have a molding capacity of 2¾ oz which can be raised to 5 oz with prepacking. Plasticizing capacity is 30 lb per hr. Model 356 has a maximum injection pressure capacity to 20,000 psi and 7 operating cycles per minute. Maximum pressure in Model 356A is 10,000 psi, with 10 operating cycles per minute. The machines handle molds up to 12 x 12 in. and have a casting area of 30 sq in. Other features include heavy-duty toggle clamp, heating chamber with 15 oz capacity, push-button controls for automatic and manual operation, volumetric feeder for accurate material delivery to plunger, thermostatic control for heating cylinder, and movable die plate for purging to change material or color. *Clifton Hydraulic Press Co., Clifton, N. J.*

**Heat Treating Furnace:** Model TF-12 portable furnace is equipped with ball bearing casters at the base, permitting the unit to be moved easily from one location to another. All power and temperature controls are mounted in the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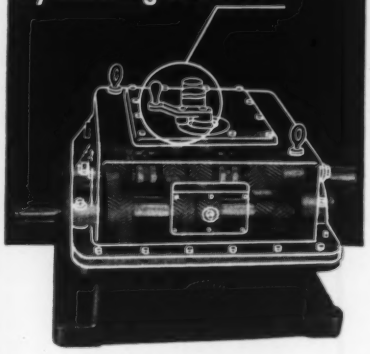
by turning the lever



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These self-contained, compact all geared type change speed Units are available in 2, 3 and 4 speed changes, providing definite ratio of speed reducing, speed increasing (or a combination of both). They were designed to fill industry's need for a very efficient, precision-built *standardized line* . . . to eliminate the high cost and delayed delivery of specially designed units. They are ideal for use on wire drawing machines, large machine tools, mixing equipment, sludge pumps, extruding machines, dry cleaning equipment, etc. Gears and pinions are Sykes Continuous Tooth Herringbone type, and shafts, bearings, clutches and housings are of the finest quality to assure the user of long, trouble-free service . . . Ratings are according to AGMA Standards, with allowance for 100% overload in starting and for momentary shock loads; these units are also designed to permit the heavy overhung loads resulting from the use of sprockets or pulleys.

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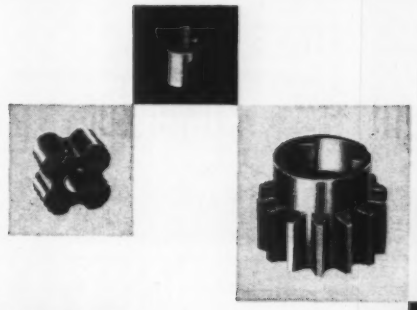
Circle 611 on page 19

furnace base and are completely wired internally. Chamber size is 36 x 48 x 12 in. U-shaped hearth contains silicon carbide heating elements, providing an operating temperature of 2200 F. Maximum heatup time is 3 to 4 hr. The door of the unit is an air-lift type which is foot-controlled. It is provided with a flame curtain which operates automatically. Power rating is 20 kw, 220 v, 60 cycle, 3 phase, with 440 v, 3 phase also available. *Pereny Equipment Co., Columbus, O.*

### Testing and Inspection

**Profile Comparators:** Two new profile projectors and comparators provide fast and accurate optical inspection of machined parts, tools, gears, forms, lamp filaments and other objects. Objects to be inspected are placed on the mechanical stage which has movements in two directions by micrometers. Coarse and fine focusing is accomplished by means of controls for vertical movement of the stage. Viewing screens on the instruments measure 8 x 8 in. on the smaller, 12½ x 11 in. on the larger instrument. Objectives provide magnifications from 10 to 50 X. Aluminized mirrors provide brilliant projected images. The light sources are 100 and 250-w lamps respectively. Both models are readily portable. *Wm. J. Hacker & Co. Inc., New York.*

**Vibration Exciter:** Model C25HB oil-cooled electrodynamic vibration exciter is designed specifically for environmental test chambers. It can be operated continuously at its full-rated sinusoidal force output of 3500 or 5000 lb and equivalent acceleration in a frequency range from 5 to 2000 cps at chamber altitudes from zero to 125,000 ft, relative humidities from zero to 95 per cent, and temperatures between −100 and 300 F. The exciter can be rotated 90 deg on its trunnion and operated in any position from vertical to horizontal. Specimen table is a flat, circular surface. The unit is used with electronic or rotary power supplies and either manual or automatic control systems. *MB Mfg. Co., New Haven, Conn.*

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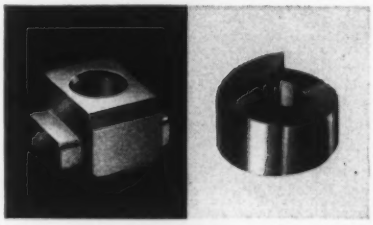

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Circle 612 on page 19

Your customers get...
Light-weight Power for
HEAVY-WEIGHT Jobs

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WISCONSIN *Heavy-Duty*
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Size and weight are often important factors in engine selection. That's one good reason why you find more Wisconsins doing more jobs than any other make of engine in a 3 to 36 hp. range. Designers and users alike go for the extreme compactness of these engines . . . the low weight-to-horsepower ratios that put an end to cumbersome, bulky power sources—and the troubles that go with them.

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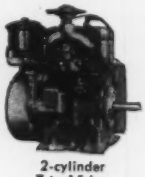
Single Cylinder
3 to 6.8 hp.

All Wisconsin Engines have the "guts" to put out . . . and to take it . . . in the toughest service. That's why every engine gives you features such as thrust-absorbing tapered roller bearings at *both* ends of the drop-forged crankshaft; high efficiency AIR-COOLING from low sub-zero temperatures to 140° F.; pump-circulated lubrication that never misses; forged connecting rods; four rings on even the smallest models; gear-driven high-tension rotary type outside magneto equipped with an impulse coupling for fast starts in any weather; adaptability to operation on kerosene, natural gas and LP fuels . . . *plus* basic High Torque design that carries the shock-loads without stalling.

Single cylinder
6 to 9 hp.



2-cylinder
7 to 15 hp.

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V-type 4-cylinder
15 to 36 hp.

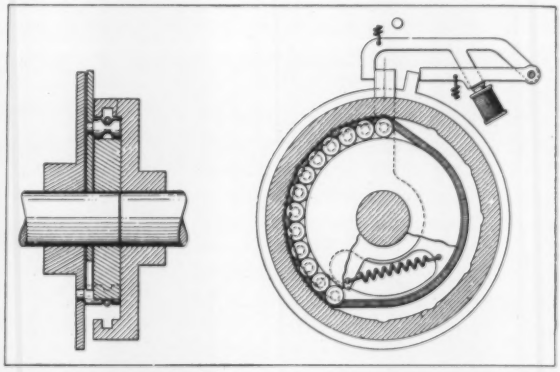
WISCONSIN MOTOR CORPORATION
*World's Largest Builders of Heavy-Duty Air-Cooled Engines*
MILWAUKEE 46, WISCONSIN

*Circle 613 on page 19*

# NOTEWORTHY Patents

### *Roller-Type Clutch*

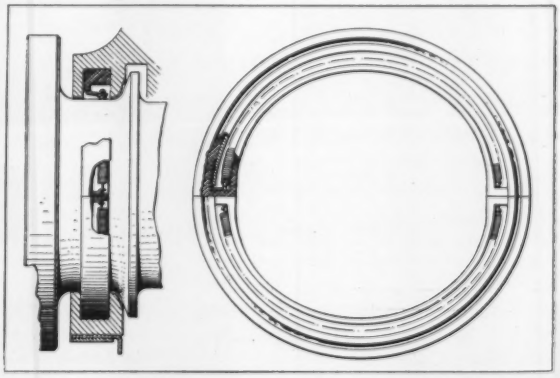
Particularly adapted to positive coupling of rapidly cycling, start-stop shaft rotations, a roller-type clutch gives instantaneous engagement and nonslip torque



transmission. When the clutch is actuated, a latch-restrained control arm is released, permitting pins at each end of the roller chain to force one or more rollers into engagement with notches in the inner periphery of the flanged driving plate. Torque path in the engaged position is from the flanged driving member, through the notch-constrained rollers to the driven member. In the disengaged position of the clutch, rollers are held out of engagement with the driving-member notches by the encircling halter spring. Action of a detent can be scheduled so as to automatically disengage the clutch after one revolution of the driven shaft. *Patent* 2,735,525 *assigned to Teletype Corp. by Frank Martindell.*

### *Split Oil Seal*

Identical and easily separated 180-degree segments, incorporating garter spring loaded sealing lips, fa-



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These new miniaturized hydraulic pumps were developed by Vickers for limited life applications such as missile and ram air turbine driven hydraulic systems . . . also for motorpump assemblies supplying emergency power on aircraft.

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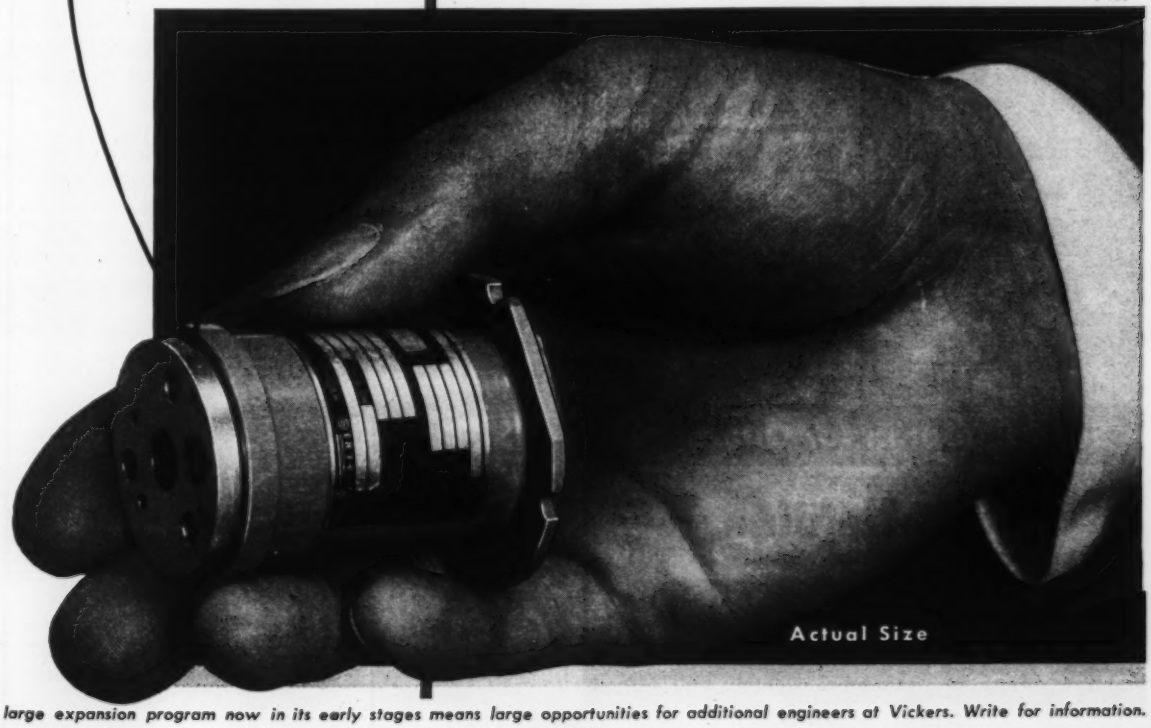
**This Hydraulic Pump has 4.3 hp output @ 3000 psi and 12,000 rpm. Weight 0.9 lb.**

7469

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PLASTICS · TOOLING · COMPRESSION · INJECTION

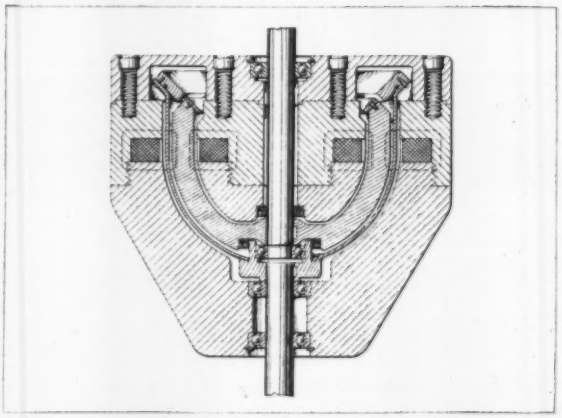
Circle 615 on page 19

## Noteworthy Patents

cilitate radial installation of a split oil seal that is intended for use on rotating shafts where axial installation is impracticable. Ends of the seal segments, which contain the rigid spring-attachment hooks, have specially formed sealing lips to ensure uniformity of lip sealing pressure over the seal-half junctions. *Patent 2,729,481 assigned to Garlock Packing Co. by Albert M. Chambers Jr., George F. Closs, Edward W. Fisher, and George R. Milligan.*

### Magnetic Clutch-Brake

Particularly adapted for vertical-axis mounting, a magnetic-particle clutch-brake employs cup-shaped magnetic gaps to facilitate centrifugal distribution



of the magnetic particles as the unit is accelerated to working speed. Undesirable migration or settling of particles when the unit is de-energized, or when it is rotating at low speeds, is prevented by seals positioned in the lower portions of the gaps. Clutch engagement occurs when particles in the gap between the thin driving shell (coupled to lower shaft) and the thick driven shell (coupled to upper shaft) are magnetically energized. Braking action is similarly developed in the gap between the driven shell and the fixed upper housing, which mates concentrically with the rotating elements. *Patent 2,754,946 assigned to Vickers Inc. by Philip H. Trickey.*

---

**Bearing material,** consisting of iron antigalling bearing surface bonded by heat and pressure to steel backing plate, can be formed into conventional bearing shapes. Ferrous surface material is sintered iron powder with small percentages of phosphorous and combined carbon. *Patent 2,747,261 assigned to General Motors Corp. by Athan Stosuy.*

---

Copies of patents briefed in this department may be obtained for 25 cents each from The Commissioner of Patents, Washington 25, D. C.

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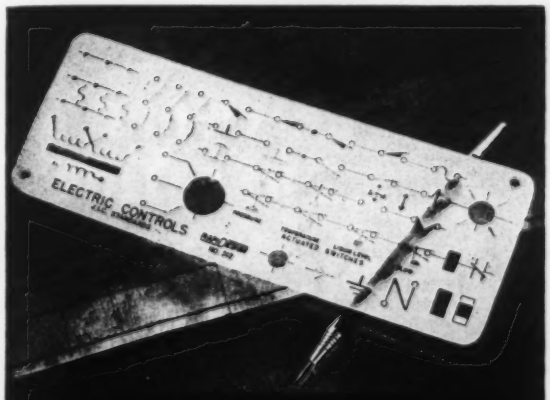
*Circle 616 on page 19*



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*Circle 617 on page 19*

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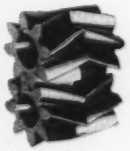

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*Circle 618 on page 19*

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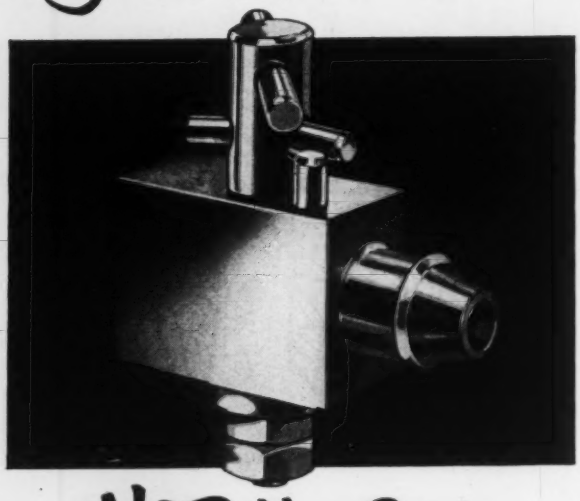
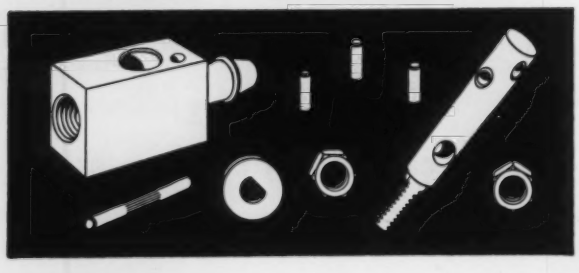


# ...NOT the Parts



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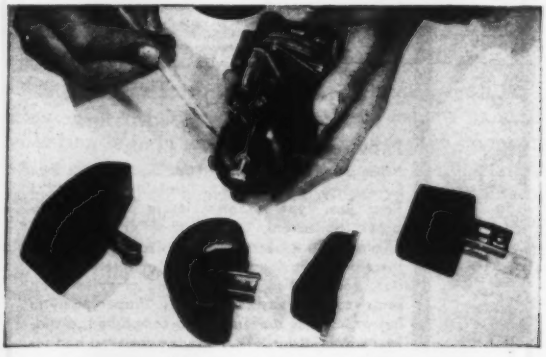
Precision Parts and Assemblies Since 1873

Circle 619 on page 19



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**Where can you use them?** For all types of aviation and jet fuels, oil, water, and many other liquids. Can be molded in variety of shapes and sizes, with or without metal arm.

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Parker
Hydraulic and fluid system components

Circle 620 on page 19

## push-pull CONTROLS

### Compression & Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. ¾" minimum bend radius.

### Three Types:

1. ***Light Duty***—Compression Ult. Load 1250 lbs.; Ult. tension 960 lbs.
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Modernize your push-pull control system with Southwest Mechanical Push-Pull Controls. Eliminate bell cranks, pulleys, and dual cables. Send for ENGINEERING MANUAL giving detailed prints and complete specifications covering materials, finishes, capacities. Please address Dept. MD-56.

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Circle 621 on page 19

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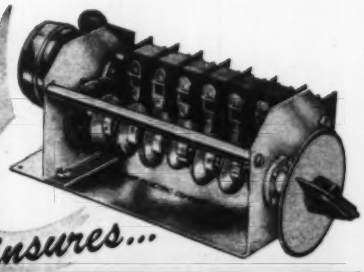

*long-lasting accuracy . . .*
*trouble-free performance in*
*timing, mixing, compounding,*
*processing and similar operations!*

Sound, practical design, quality components and precision-controlled assembly insure the long-lasting dependability of ZENITH Multi-Circuit Timers. They are specified as standard components in countless commercial and industrial applications, as well as laboratory equipment and home appliances.

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*Circle 622 on page 19*

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*Circle 623 on page 19*

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Automotive Spring Loaded

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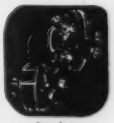
Oil or Dry Multiple Disc

Heavy Duty Over Center



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The automatic rotating cams of the engaging device produce repetitive engaging and disengaging cycles of the driving clutch and braking clutch assemblies. 10,000 engagements and disengagements, four cycles per minute, give a very conclusive wear test on the friction facings. The repetition and standardization of this test procedure constitute an accurate analysis of the wearing quality of friction facing materials used in ROCKFORD CLUTCHES. Let ROCKFORD engineers utilize this testing machine to insure the stamina of the clutch facing material in your products.

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**CLUTCHES**

*Circle 624 on page 19*




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**for Complete Conditioning and Control of Compressed Air for Powering Pneumatic Tools—Cylinders—Valves and Appliances.**

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¼"
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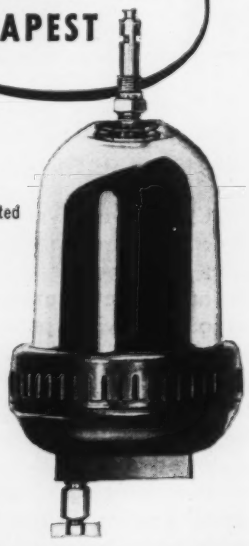

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1918 S. KOSTNER AVE. • CHICAGO 23, ILL.

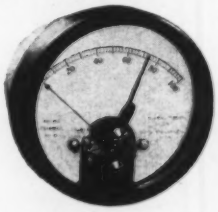
*Circle 625 on page 19*

# NEW METER-RELAYS

## FROM 0-5 MICROAMPERES - UP

**Ruggedized-Sealed, Black Bakelite, or Clear Plastic Cases**
*D'Arsonval indicating meters with built-in locking contacts for sensitive and accurate control or alarm*

**TRIP POINT ADJUSTABLE** to any point of scale arc. Sensitive to changes as little as 1%. One contact carried on moving pointer. The other on an adjustable pointer. When two pointers meet, contacts close and lock. Holding coil is wound directly over moving coil, locking action is electro-magnetic. Reset can be manual or automatic. Spring action in contacts kicks them apart forcefully.



Model 255-C, Single Contact, High Limit, 0-10 Volts DC $42.50

Model 461-C, Double Contact 10-0-10 Microamps DC $83.25

**Ranges** from 0-5 microamperes or 0-5 millivolts up, full scale. Temperature ranges from 0-300°F. (10 ohms external) have bimetal cold junction compensation.
**Standard Contact Rating** 5 to 25 milliamperes DC. Can be built up to 100 milliamperes DC.
**Ruggedized-Sealed** metal cases are 2½", 3½" and 4½" round, shock-mounted, gasket-sealed.
**Black Bakelite** case, 4½" rectangular.
**Clear Plastic cases** are 2½", 3¾", and 4½" rectangular. Maximum visibility and lower cost.

Panel meters and indicating pyrometers are also available in ruggedized-sealed, black bakelite or clear plastic cases. New 40-page catalog lists prices and specifications for meter-relays, meters, pyrometers and automatic controls using meter-relays. Write for Catalog 4-A, **Assembly Products Inc., Chesterland 51, Ohio. HAmilton 3-4436 (Cleveland, O.) West Coast: Desert Hot Springs 51, Calif. Phone: 4-3133 & 4-2453**

**Booth 1702, Metals Show, Oct. 8-12, Cleveland, O.**
*Circle 626 on page 19*

# INSURE *Proven Quality* with JONES PLUGS AND SOCKETS

P-306-CCT Plug, Cable Clamp in Cap.

**Jones Series 300 Illustrated. Small Plugs & Sockets for 1001 Uses. Cap or panel mounting.**

S-306-AB Socket with Angle Brackets.

- Knife-switch socket contacts phosphor bronze, cadmium plated.
- Bar type Plug contacts brass, cadmium plated, with cross section of 5/32" by 3/64".
- Insulation molded bakelite.
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CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

*Circle 627 on page 19*

# MARSH QUALITY

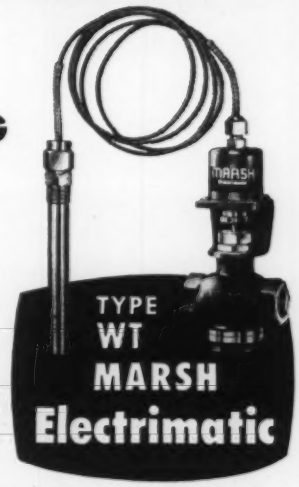
*. . . in a Temperature-actuated*

## REGULATING VALVE

*Smooth, modulating control*

*— for brine lines in cooling systems*

*— for condensers where pressure line is not desired*




A temperature actuated regulating valve you can depend on—the Marsh Electrimatic Type WT for pressures up to 150 psi, water or brine, and up to 15 lbs. for steam (250° maximum temperature). It opens as temperature rises, closes as temperature falls, to give an ideal, smooth, modulated control. Can be mounted in any position; serviced without breaking connections. Seat beads are monel to eliminate wire drawing. Sturdy, two-ply bellows assures extra service life. Temperature ranges of 20°F.-60°F.; 60-100, 100-140, 140-180, 160-220. All standard sizes from ⅜" through 4". All styles of temperature bulbs.

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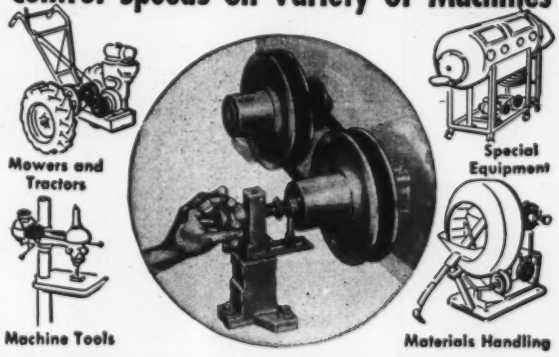
**Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd Street, Edmonton, Alberta, Canada**

*Circle 628 on page 19*

# SPEED SELECTOR

## VARIABLE PITCH SHEAVES

### Control Speeds on Variety of Machines

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**SPEED SELECTOR INC.**

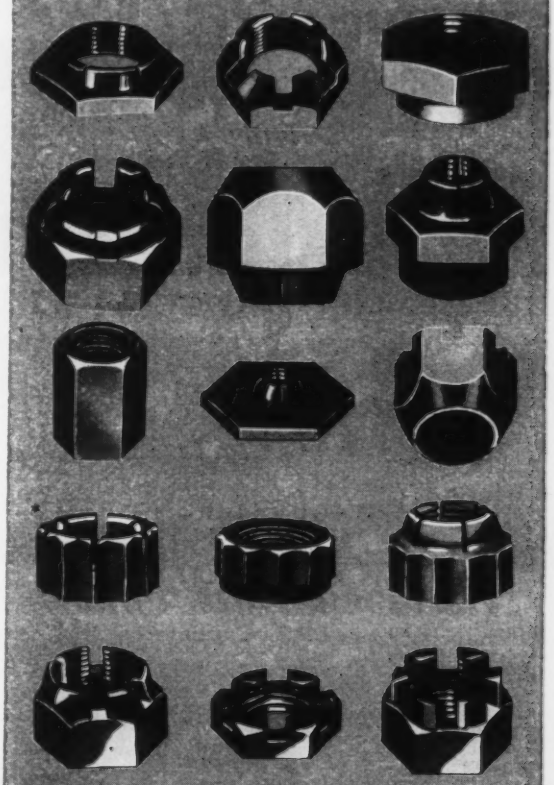
**P. O. BOX 312-B • CHAGRIN FALLS, OHIO**

*Circle 629 on page 19*

# SPECIAL NUTS

to specs. 7/16" - 4-1/4" cross flats

special machines + large stock of material x years of experience = speedy deliveries high quality low prices



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*Also 12 Pointer brochure on request.

**NATIONAL MACHINE PRODUCTS COMPANY**

*Manufacturer of Standard and Special "12 Pointer and Hexagon Nuts . . . "Huglock" and "Marsden" lockNuts.*

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*Circle 630 on page 19*

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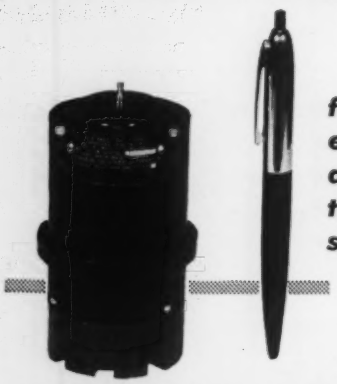

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(subject to prior sale)

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| 1F | 3HG | 3HDG | 5D | 1F400* |
| 1HCT | 3F | 5HG | 5HDG | 1HCT400* |

*400cy units are available to commercial specs only. All others are available to *both* military and commercial specs.

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| ☐ 1HCT | ☐ 3F | ☐ 5HG | ☐ 5HDG | ☐ 1HCT400* |

*Available to commercial specs only.

☐ Units should meet military specs. ☐ Please send me FREE booklet

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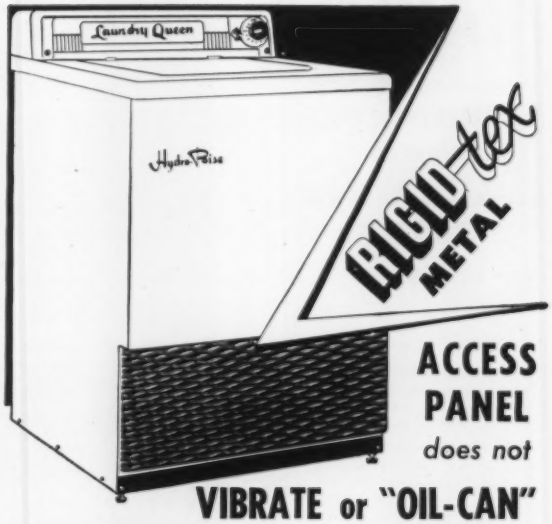


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*Sales Representatives in Principal Cities*

Circle 632 on page 19

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*Kitchen Aid* mixers, by Hobart, are sold to the American Homemaker with a guarantee of exceptional performance and service. Understandably, *every* component must be the finest quality available.

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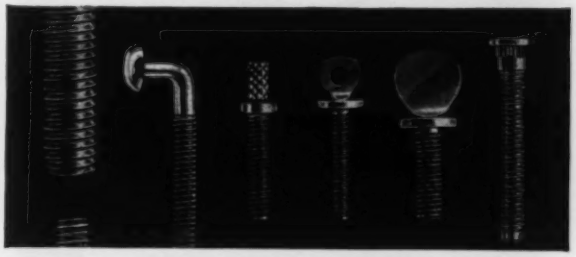

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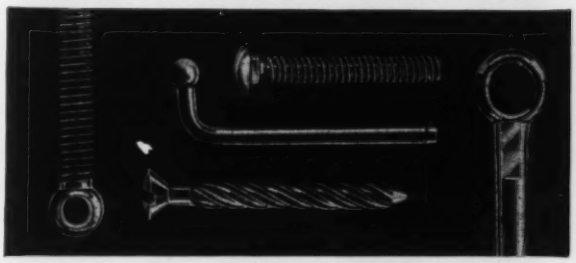

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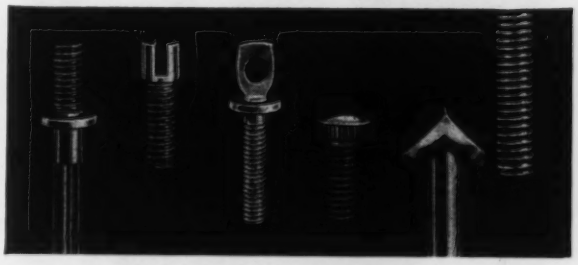

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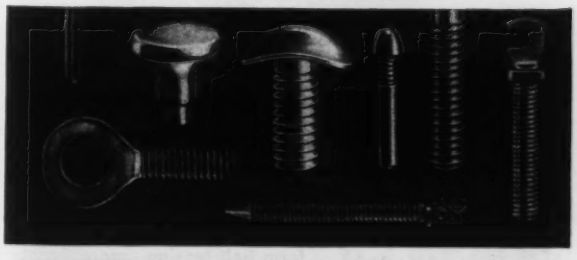

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on EBERT'S 4 All-Purpose

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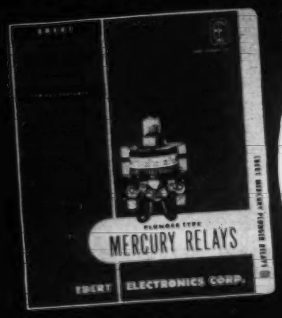


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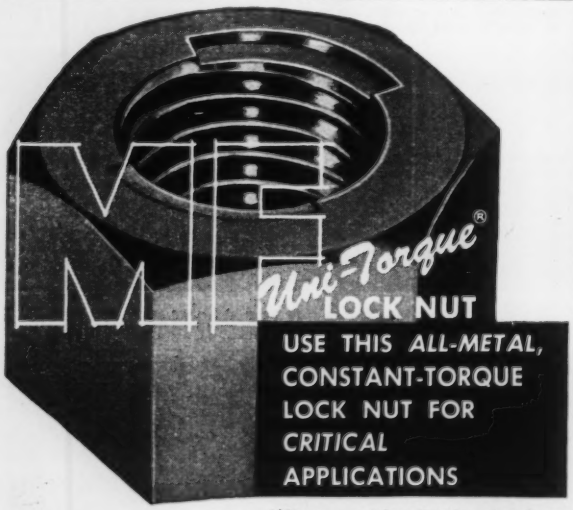


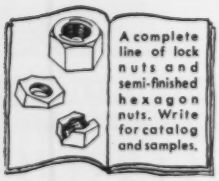


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*Circle 638 on page 19*


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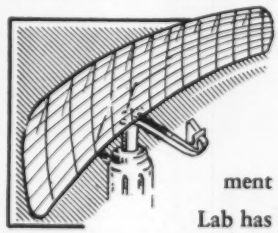

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RAYTHEON

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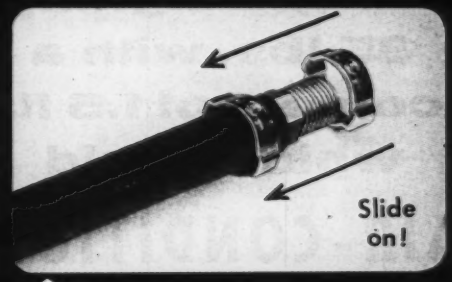


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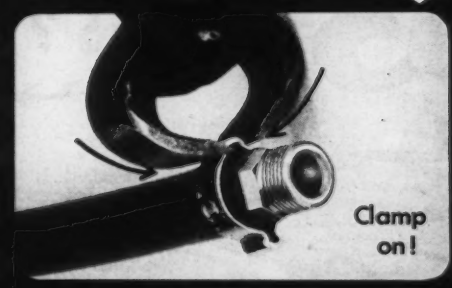


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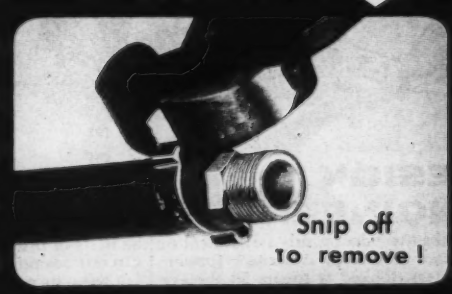


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*Write for complete descriptive information, stock sizes, prices and the name of your nearby Circle Clamp Distributor.*

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Circle 641 on page 19

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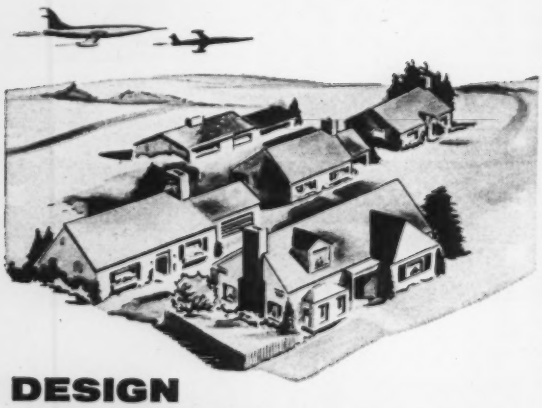

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*Circle 642 on page 19*



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Westinghouse

ELECTRONIC TUBE DIVISION · ELMIRA, N. Y.

*Circle 643 on page 19*


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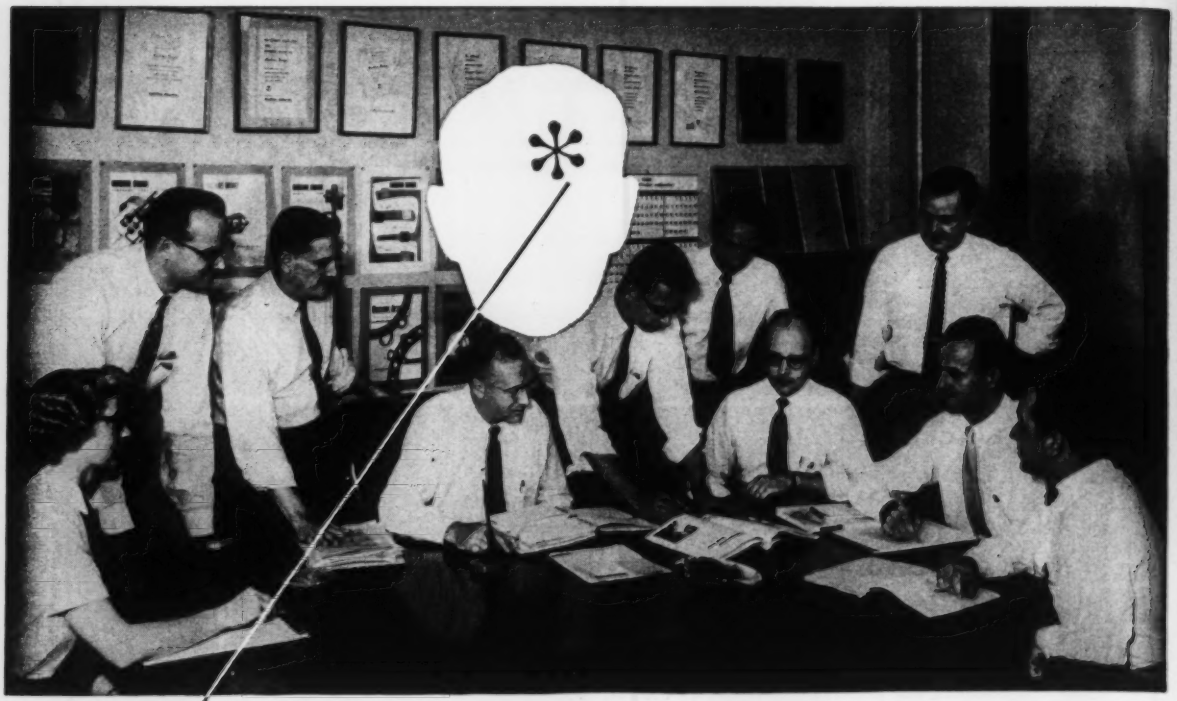

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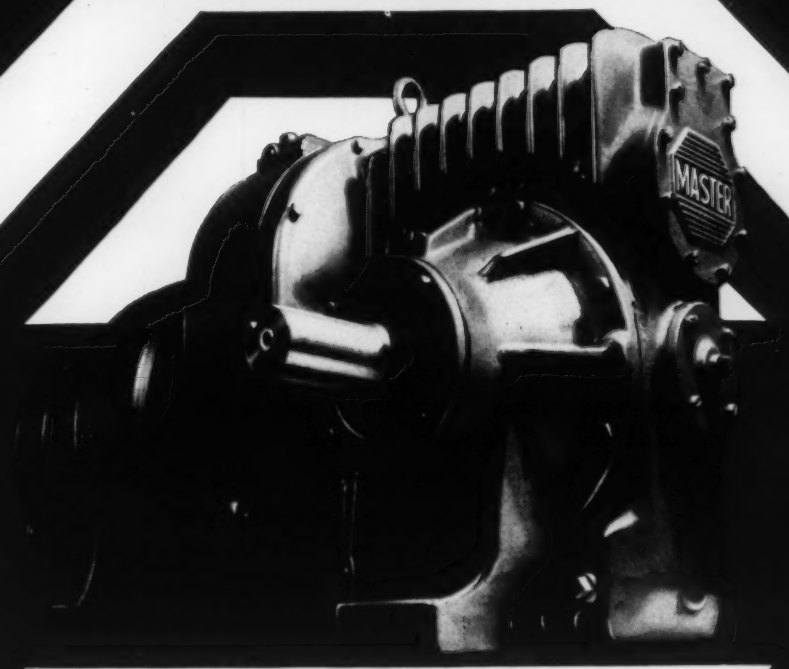


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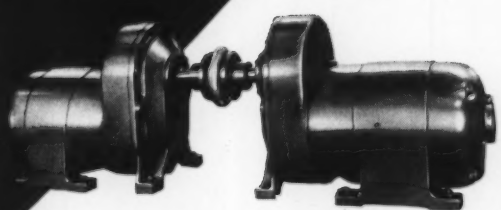

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